INVENTORY AND MONITORING OF BALD EAGLES AND OTHER RAPTORIAL BIRDS OF THE SNAKE RIVER, IDAHO

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IDAHO BUREAU OF LAND MANAGEMENT TECHNICAL BULLETIN NO. 95-12 APRIL 1995

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Executive Summary

The South Fork Raptor Project, a five-year effort, was initiated in 1994, with two primary objectives: 1) to monitor bald eagle productivity in Southeast Idaho, and 2) to develop a monitoring program for all raptors in the Snake River study area.

In 1994, 39 bald eagle territories were known within the Southeast Idaho portion of the Greater Yellowstone Ecosystem, including 3 new territories first located in 1994. Twenty of these breeding areas include Bureau of Land Management managed public lands, 26 include National Forest lands. In 1994, 38 of 39 known territories were occupied, and 36 were active (incubation occurred). Known productivity at these sites was 1.13 advanced young per occupied nest (43 young at 38 breeding areas). In 1994, 28 nestlings were banded. Known historical information and key use areas were documented for three bald eagle breeding areas: Wolverine Creek (18-IS-10), Cress Creek (18-IS-12), and Confluence (18-IS-13).

In 1994, our primary accomplishment in development of a raptor monitoring program was documentation of a literature review for each of the raptorial species involved to include specific detection methods for surveys, occurrence in this region, ecology and reproductive biology, and habitat relationships. We also initiated presence/absence surveys. In this first year, we used a two-step system of simple random sampling without replacement to select square mile sections for sampling, and then attempted to determine raptor occurrence within each of 16 quadrats of 40-acres size within each section. For 1995, we have developed a more efficient sampling regime to include Latin Square plus 1 for initial sample selection. This methodology allows us to avoid over-sampling in areas of relatively poor habitat (=low occurrence), a likely result of stratified sampling. We will also use adaptive sampling to identify areas used by the more rare species. This methodology will allow us to focus searches within areas and habitats where rare species have been detected and still avoid sampling bias. We will also refine habitat classifications around locations where raptors are detected.

We have thus far documented the occurrence of 19 raptorial species within the Snake River study area, and suspect that 7 more species may be found. Several of these species, notably red-tailed hawks and great horned owls, were very cosmopolitan in their habitat selection, whereas others, like flammulated owls, appear to be very selective. We correlated raptor observations with a broad-scale vegetative cover scheme. We found that Snake River corridor habitats are highly modified by human uses. Areas with natural vegetation, or with the management capacity to be regenerated to a more natural vegetation regime (i.e. Public Lands), are of great importance to maintenance of biological diversity in this ecosystem.

Introduction

This report documents the first year of progress in a five-year project to monitor raptorial birds within the Snake River ecosystem of southeastern Idaho. This project has two primary objectives: 1) to continue monitoring of bald eagle productivity and bald eagle habitats of southeast Idaho; and 2) to develop a monitoring program for the entire guild of raptorial birds found within a more narrowly defined Snake River study area. The goal is to develop monitoring tools that can be applied to the conservation of the broader biological community.

There is growing recognition of the need to conserve functional ecosystems rather than just individual species. A reliable resource inventory and long-term monitoring program are central to the conservation of rare species and thus, more broadly, of biological diversity at the ecosystem level (Murphy and Weiss 1988). Successful monitoring depends upon the ability to determine habitat relationships and to track population trends. However, among the more difficult technological tasks associated with comprehensive ecosystem management is development of statistically reliable and economically feasible tools for the inventory and monitoring of low density, clumped density, rare or difficult to detect elements of biological diversity. This project is a test case. Our subjects are the diverse group of raptorial birds found within the Snake River corridor and nearby uplands. As a first step, we are developing statistically valid presence/absence sampling methods to determine breeding raptor occurrence and associated habitat correlations, a broad-scale monitoring program. Then we will build from this information to estimate relative abundance of breeding pairs, refine habitat relationships and develop a fine-scale monitoring design. We will apply newly developed adaptive sampling methods for those species that are particularly rare in the study area. This information will be used to suggest measurement and monitoring methodology applicable to an array of biological resources.

As vagile and visible predators, raptors can be an early warning of habitat degradation or species decline farther down the food chain. Raptors with narrow ecological niches, such as prairie falcons and Cooper's hawk, may be particularly sensitive ecological indicators (Steenhof and Kochert 1982, Saab 1990). These species are worthy of monitoring emphasis because changed environmental conditions can be detected in a raptor population's demography (Newton 1979). Although raptor community ecology is not well understood, raptors may serve as good models of predator guilds (Jaksic 1985). And several raptorial species generate considerable interest in and of themselves (e.g. Ollendorf 1989).

The Snake River system in Southeast Idaho houses significant biological resources deemed worthy of management focus (BLM and Forest Service 1991). The 119 river miles and associated riparian corridor in these river reaches have been labeled by the U.S. Fish and Wildlife Service as the single most significant wildlife habitat in all of wildlife-rich Idaho. Our study area includes this valuable riparian corridor plus the higher elevation areas within 1 mile of the river. We suspect that up to 15 hawk and eagle species and at least 10 owl species (Table 1) reproduce within our study area. Among these, Swainson's hawk and flammulated owl, are neotropical migrants. Swainson's hawk, merlin, and boreal owl are BLM sensitive species in Idaho. Southeast Idaho's 39 active bald eagle nesting territories, 14 in the smaller study area, are among the most productive in the entire Greater Yellowstone Region.

Objectives

1. Determine bald eagle productivity and document habitat observations for bald eagle territories within the Idaho portion of the Greater Yellowstone Ecosystem. Specific 1994 tasks within this objective are:

a. Complete bald eagle nest survey forms for each breeding area.

b. Monitor and assess the effects of human disturbance to each breeding area as determined

during activity and productivity surveys.
c. Provide preliminary identification of key use areas and important habitat use areas for the following bald eagle breeding areas: Cress Creek (18-IS-10), Wolverine Creek (18-IS-12), and Confluence (18-IS-13).

II. The overall goal of this five-year project is to develop an inventory and monitoring program for all raptorial birds of the Snake River study area. The 1994 objective is to initiate Phase 1, presence/absence surveys with stratified randomized sampling, to determine raptor species occurrence and broad-scale habitat relationships (see methods).
a. Develop preliminary presence/absence sampling regimes and select initial samples.
b. Identify broad-scale vegetation types within selected sample areas.
c. Complete presence/absence surveys for raptors within selected sample areas.
d. Complete a thorough and current literature review for each of the raptorial species involved to include specific detection methods for surveys, occurrence in this region, ecology and reproductive biology, and habitat relationships. Raptor species to be included in this analysis are shown in Table 1.

Table 1. Raptor Species Codes for raptorial birds to be inventoried and monitored in the South Fork study area, 1994-1998.

Raptor Species	Scientific Name	Code	Species Number
Bald Eagle	Haliaeetus leucocephalus	Ha. le.	01
Golden Eagle	Aquila chrysaetos	Aq. ch.	02
Osprey	Pandion haliaetus	Pa. ha.	03
Turkey Vulture	Cathartes aura	Ca. au.	04
Red-tailed Hawk	Buteo jamaicensis	Bu. ja.	05
Swainson's Hawk	Buteo swainsoni	Bu. sw.	06
Feruginous Hawk	Buteo regalis	Bu. re.	07
Northern Harrier	Circus cyaneus	Ci. cy.	08
Northern Goshawk	Accipiter gentilis	Ac. ge.	09
Cooper's Hawk	Accipiter cooperii	Ac. co.	10
Sharp-shinned Hawk	Accipiter striatus	Ac. st.	11
Peregrine Falcon	Falco peregrinus	Fa. pe.	12
Prairie Falcon	Falco mexicanus	Fa. me.	13
Merlin	Falco columbarius	Fa. co.	14
American Kestrel	Falco sparverius	Fa. sp.	15
Great Horned Owl	Bubo virginianus	Bu. vi.	16
Long-eared Owl	Asio otus	As. ot.	17
Short-eared Owl	Asio flammeus	As. fl.	18
Western Screech Owl	Otus kennicottii	Ot. as.	19
Burrowing Owl	Athene cunicularia	At. cu.	20
Great Gray Owl	Strix nebulosa	St. ne.	21
Barred Owl	Strix varia	St. va.	22
Northern Pigmy Owl	Glaucidium gnoma	Gl. gn.	23
Flammulated Owl	Otus flammeolus	Ot. fl.	24
N. Saw-Whet Owl	Aegolius acadicus	Ae. ac.	25
Boreal Owl	Aegolius funereus	Ae. cu.	26

Study Area

The 119 mile long reach of Snake River corridor identified in the BLM and Forest Service 1991 Snake River Activity/Operations Plan is the core of the study area (figure 1). This area includes the South Fork of the Snake River from Palisades Dam beyond the confluence to Market Lake Canal, and Henry's Fork from St. Anthony to its confluence with the mainstem Snake. The study area is expanded to include upland habitats within 1 mile on each side of river. In preliminary studies, the investigators located breeding raptors which nest within this expanded area and rely in part upon the riparian bottom for foraging habitat.

The upper section of the South Fork below Palisades Dam flows through a mountain valley, Swan Valley, Idaho. It then flows into a rugged, deeply incised canyon approximately 26 miles in length. The lower portion of the South Fork and the Henry's Fork below St. Anthony meander across broad, braided flood plains. Much of the South Fork in these lower reaches is contained by a dike system.

Much of the river is bordered by riparian cottonwood gallery forests recognized as among the largest and most intact in the western United States. Beyond the floodplain, landscapes on each side of the river include a rich diversity of vegetative cover and topographical relief: conifer and aspen covered foothills, park-like pasture lands and cultivated crop lands; precipitous canyon walls; sage, mountain mahogany, and juniper covered slopes; and steep, rocky mountains. The lower reaches feature biologically rich sloughs and wetlands. The South Fork and lower reach of the Henry's Fork are recognized as a primary biological asset of the Greater Yellowstone Ecosystem.

Bald eagles are monitored within a larger region, the Idaho portion of the Greater Yellowstone Ecosystem. This area includes Southeast Idaho west to Interstate 15 from the Montana border to Idaho Falls, and the Snake River watershed south to the Wyoming border at the upper end of Palisades Reservoir. The area includes the Snake River study area plus the upper Henry's Fork in Island Park, outlying lakes like Sheridan Reservoir, and Henry's Fork tributaries, the Falls and Teton River watersheds.

Methods

Bald Eagle Monitoring

All known and suspected bald eagle breeding areas are surveyed. Specific data to be obtained includes: nest occupancy, breeding activity, breeding success, and number of advanced young produced. Definitions used for bald eagle reproductive terminology are as follows:

Breeding area or territory. This refers to the area used by one territorial pair of adult bald eagles and containing one or more nests.

Occupied breeding area or nest. A breeding area or territory, or nest within a breeding area or territory, with evidence of bald eagle use during part of the breeding season. Occupancy occurs if a) two adults are seen at or near an empty nest within the breeding season, b) one adult and one subadult are seen at or near a nest during the breeding season and there are displays of reproductive behavior, c) there is clear evidence of recent nest repairs or new nest construction, or d) observations that identify the nest as active as defined below.

Active breeding area or nest. Incubating pair. A breeding area or nest within a breeding area or territory, with clear evidence of bald eagle reproductive effort during the breeding season. An active nest is one where incubation, eggs, or nestlings are observed. Incubation posture does not necessarily infer incubation, and actual incubation should be assumedonly if an adult remains in the posture for several hours or an exchange of incubation duty by adults is observed. Revised GYE Bald Eagle Working Group guidelines substitute Active with the term "Incubating Pair".

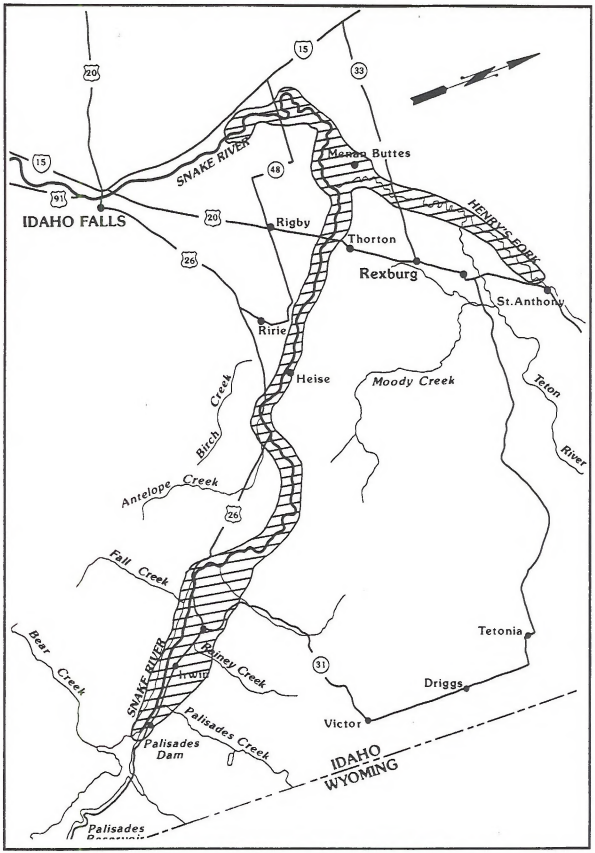


Figure 1. Snake River study area. This map is taken from the Snake River Activity/Operations Plan (USDI BLM and USDA Forest Service 1991). Scale 1 : 500,000

Successful breeding area or nest. A breeding area or territory, or nest within a breeding area or territory, where advanced young are produced. Advanced young are young of the year at or near fledging age.

All nest sites are visited a minimum of twice: early for an activity (incubation) check and later for a productivity check. In most cases, additional activity checks are necessary to more clearly document activity or to locate new alternate nest sites. Nesting chronology is monitored where reliable data can be obtained. Activity checks are completed by a combination of aerial and ground or boat surveys as suggested by experience with past surveys (e.g. Whitfield et al 1993). Most early ground checks are from long distance with spotting scopes to avoid disturbance to adults.

Later visits are made to measure productivity at active nest sites. Nestlings are banded during this visit where nest trees can be safely climbed. Our experience of 11 years of monitoring bald eagle nesting activity and productivity in this region suggests an area-specific strategy for bald eagle monitoring that is outlined in Appendix Table 1.

Development of Raptor Monitoring Program

Our raptor inventory is iterative over the five years of the project, with an additive progression through phases as the data is collected and analyzed. We include here a description of the methods to be used over the life of the project to provide perspective for each year's work. Sampling methods, including raptor species detection and estimation of relative abundance and breeding productivity, must be species specific.

Once our inventory has provided a reliable baseline, we will develop a long-term monitoring program for the raptors of the South Fork study area. This program will employ a sampling design that will yield statistically reliable species-specific measures of breeding pair density and productivity. Time and cost efficiency will be emphasized to ensure that long-term monitoring is practical. Suggestions for applicability to other areas and other biological groups will be made.

Breeding Raptor Detection.

We apply species-specific raptor detection methods. We provide a literature review of raptor detection methods in the results section. We will also analyze delectability models from a statistical perspective as the project progresses.

Raptor Inventory

Our raptor inventory occurs in two phases as follows:

Phase 1. Presence/Absence Sampling. Sample sites are selected to cover a broad array of biological and physical attributes; such coverage will help assure adequate representation of species composition and distribution over the study area. Sampling must be exhaustive enough to minimize under-sampling effects on patterns while allowing true patterns or gradients across the study area to be identified, described and predicted. With respect to monitoring, sampling must also ensure that study-wide trends and change can be distinguished from localized fluctuations (McKenzie et al. 1991). Hence the number, placement, and size of the sample sites will require careful consideration from both the biological and statistical perspectives.

The study area will be stratified on habitat classifications and other physical factors such as land use. Sample site placement, size and number will depend in part on size of the stratum, homogeneity within strata, and degree of spatial coverage over the stratum including edges. Data recorded at each sample site will consist in part of the following: sample date and geographic location, stratum type, habitat patchiness with estimated relative percentages of patch-type, raptor species present, and the within site geographical location of individuals, nest sites and the like. Statistical analyses will provide information on species composition and habitat associations. These results will be used to predict geographical

distributions of presence for individual species and species assemblages over the study area. To be of value to a long-term, broad-scale monitoring program, these predictions must be ground-truthed and refined.

In our first cut at presence/absence sampling in 1994, we did a two-stage simple, random sample selection, first by 10-mile river section, and then by 1 square mile topographic legal sections within river sections. We used mapped legal sections because there are often section markers on the ground that aid in sample location. We selected from all square mile sections that were at least 50% within 1 mile of the river. We then individually sampled all 40-acre quadrats (16 per square mile section) within selected sections.

Data and results obtained from this survey will be invaluable for the second phase of the project: estimating relative abundance and distribution of key species This phase will commence in the third year of the project.

Phase 2. Estimating Relative Abundance. Sampling to estimate relative abundance is considerably more complicated than the methods used to determine presence or absence of a species. The area or quadrat size that can be exhaustively searched for breeding individuals will tend to be smaller than the sample site size discussed above, and is likely to be somewhat species-specific. At this finer scale, some species (e.g. flammulated owls, *Otus flammeolus*) could occur at relatively low densities with spatial distributions that appear to be aggregated so that locating quadrats with species present may be more difficult. Once presence is established at a selected sample site, detecting all individuals, that is obtaining accurate counts, can be difficult. Detection methods will be species-specific.

Adaptive sampling techniques (e.g. Thompson 1990, Munholland and Borkowski 1993b) are very useful and efficient when searching for rare or spatially clustered populations, since sampling effort is dependent on species presence. Statistical methods which account for less than perfect detectability of individuals within selected sites must also be applied to the recorded abundances; in some cases such methods exist, while in others, detectability models must be developed.

Nesting activity and productivity

Our raptor inventory is adaptive and cumulative as we build our data baseline over the years. Later in the project, we will monitor all raptor nest sites to measure productivity parameters, as we now do for bald eagles. This monitoring is complicated by the dynamic nature of the activities we are measuring. For example, nesting surveys that begin late in the nesting season may miss nests that fail early, and therefore overestimate nesting success and productivity (Steenhof and Kochert 1982). Raptorial birds that nest in the study area begin to actively repair and build nests and to lay and incubate eggs in March-June. During this stage, we recheck all nests located earlier, usually from a long distance with a scope, to determine if nests are occupied and identify species. We attempt to determine nesting activity during the incubation period in a non-invasive manner that does not displace incubating adults. We also document activity at newly constructed or occupied nests found throughout the breeding season. Definitions for occupied and active nests follow those used for bald eagle monitoring.

We return to a sample of known active nests after the pairs are at least 10 days into incubation in 2 or 3 person teams to measure clutch size. We will use tools designed to minimize time at nests, e.g. Hayward (1993). We later revisit nests to document nesting success and number of young produced.

Habitat description

For Phase 1 surveys (presence/absence) completed in 1994 and reported here, we characterized each 40 acre sample quadrat by general vegetation cover type according to the system developed by Ulliman et al. (1991), which includes 30 cover types (Table 2). We indicate the

dominant cover type found within each quadrat, with recognition that many quadrats feature a complex mosaic of vegetative cover types (Appendix Table 5).

As the project matures, our habitat measures will become more refined to characterize features selected by individual raptor species. We hope to characterize, at a landscape level, habitat features found within areas estimated to include the home ranges of nesting raptor pairs. We will also measure habitat features around all nest sites to determine those features of importance to nest occupancy and success (see Appendix A, Table 4). This step will occur after fledglings have left the area, from August-October in most cases.

Table 2. Snake River study area vegetative cover types after Ulliman et al. (1991).

Level I	Level II	Level III
1 Urban	11 Residential	111 Residential
	12 Commercial	121 Commercial
	13 Industrial	131 Gravel pits, quarry
	14 Transportation	141 Roads, transportation services
2 Agriculture	21 Cropland, Pasture	211 Tilled cropland
		212 Permanent pasture
	24 Other	241 Buildings and associated areas
		242 Irrigation canals
		243 Dikes and dams
3 Rangeland	31 Grassland	311 Upland grasslands
	32 Shrubland	321 Sagebrush-bitterbrush
		322 Mountain mahogany
		323 Upland shrubland
4 Forestland	41 Deciduous	411 Aspen, closed (› 75% cover)
		412 Aspen, open (‹ 75% cover)
	42 Evergreen	421 Douglas-fir
		422 Juniper
5 Water	51 Riverine	511 Upper perennial
		512 Lower perennial
6 Riparian	61 Nonwoody	611 Grasses
		612 Sedges
	62 Woody	621 Willow
		622 Dogwood
		623 Cottonwood
7 Barrenland	74 Exposed Rock	741 Bedrock outcrops
		742 Scree slopes

Results

Bald Eagle Activity and Productivity

In 1994 we documented activity and productivity at 39 bald eagle breeding areas (Table). All observations at individual nesting areas are reported elsewhere (Whitfield et al. 1994). Bald eagle productivity rebounded in 1994 from the very low levels reported in 1993. In 1994, 38 of 39 known territories were occupied, and 36 were active. Known productivity at these sites was 1.13 advanced young per occupied nest (43 young at 38 breeding territories). Most notable productivity increases were at Palisades Reservoir and in Island Park. The 5 nests found near Palisades Reservoir produced 7 advanced young in 1994 (only 1 in 1993, 7 in 1992). The 9 active pairs of the South Fork Canyon produced 11 young in both 1993 and 1994, slightly below the average performance of these nests in recent years, and the lower river nests were also similar in productivity in the two recent years. However, the Continental Unit rebounded from only 8 advanced young at 16 established nests in 1993 to 18 advanced young in 1994. The Riverside Territory (18-IC-15) in Island Park finally became active again; a new nest site was located in this territory that had not been detected as occupied since 1990.

Overall 1994 productivity for the Idaho/GYE nesting territories was 1.13 young/occupied nest. Although this productivity is relatively low in the context of the past 7 years (Table 3), it should be noted that 6 new breeding territories have been located in the last 3 years, 3 of these in 1994. Breeding attempts in new territories are frequently unsuccessful or low in productivity.

Three new breeding territories were located in 1994. These include the Market Lake territory (18-IS-22) on the main Snake below the confluence, the Upper Teton territory (18-IS-21) in Teton Valley, and a nesting attempt on the Buffalo River (18-IC-17) in Island Park. In 1994, 28 Idaho/GYE nestlings were banded with numbered Fish and Wildlife Service leg bands on the right leg and color bands with stamped two digit alphanumeric codes on the left leg.

Table 3. Advanced young per occupied nest with known outcome for years 1988-1994.

Year	Advanced young/occupied nest
1988	1.70
1989	1.35
1990	1.59
1991	1.45
1992	1.23
1993	0.69
1994	1.13

Table 4. Activity and productivity status for bald eagle breeding territories within the Idaho portion of the Greater Yellowstone Ecosystem, 1994.

TERRITORY NAME	TERRITORY NUMBER	STATUS	NUMBER ADVANCED YOUNG	NUMBER YOUNG BANDED	COMMENTS
PALISADES RESERVOIR AREA					
Hoffman	18-IS-01	Active, successful	2	2	
Williams Creek	18-IS-02	Active, successful	1	1	
Van Point	18-IS-03	Active, successful	2	2	New alternate nest
Edwards Creek	18-IS-17	Active, unsuccessful	0	0	
King Creek	18-IS-18	Active, successful	2	2	Rebuilt old nest
SOUTH FORK SNAKE RIVER					
Palisades Creek	18-IS-04	Active, successful	2	2	
Swan Valley	18-IS-05	Active, successful	1	0	New alternate
Conant Valley	18-IS-06	Active, successful	2	2	
Pine Creek	18-IS-07	Active, unsuccessful	0	0	
Dry Canyon	18-IS-08	Active, successful	2	0	
Gormer Canyon	18-IS-09	Active, successful	2	2	
Wolverine	18-IS-10	Active, successful	1	1	
Antelope Creek	18-IS-11	Active, successful	1	0	
Cress Creek	18-IS-12	Active, unsuccessful	0	0	Nest blowdown
MAIN SNAKE RIVER					
Confluence	18-IS-13	Active, successful	1	0	New alternate
Market Lake	18-IS-22	Active, successful	1	1	New territory
LOWER HENRY'S FORK, SOUTH FORK, FALL AND TETON RIVERS, SNAKE UNIT					
Cartier Slough	18-IS-14	Active, successful	1	0	
St. Anthony	18-IS-15	Active, successful	2	0	
Singleton	18-IS-16	Active, successful	1	0	
Lower Fall River	18-IS-19	Unoccupied,	0	0	No eagles seen
Menan Buttes	18-IS-20	Active, successful	1	0	
Upper Teton River	18-IS-21	Active, successful	0	0	New territory

Table 4. Activity and productivity status for bald eagle breeding territories within the Idaho portion of the Greater Yellowstone Ecosystem, 1994 (cont.).

TERRITORY NAME	TERRITORY NUMBER	PRODUCTIVITY STATUS	NUMBER ADVANCED YOUNG	NUMBER YOUNG BANDED	COMMENTS
CONTINENTAL UNIT, UPPER HENRY'S FORK SNAKE RIVER					
Kerr Canyon	18-IC-01	Active, successful	2	0	
Pine Haven	18-IC-02	Occupied,	0	0	
Box Canyon	18-IC-03	Active, successful	1	1	
Coffee Pot	18-IC-04	Active, unsuccessful	0	0	
Bishop Lake	18-IC-05	Occupied,	0	0	
Sheridan	18-IC-06	Active, successful	2	0	
Lucky Dog	18-IC-07	Active, successful	2	2	New alternate
Henry's Lake	18-IC-08	Active, unsuccessful	0	0	
Staley Springs-Targhee Creek	18-IC-09	Active, successful	2	2	
Hale Canyon	18-IC-10	Active, successful	1	1	
Moonshine	18-IC-11	Active, successful	1	1	
Last Chance	18-IC-12	Active, successful	2	2	
IP Bills	18-IC-13	Active, successful	1	1	
Flat Rock	18-IC-14	Active, successful	1	1	
Riverside	18-IC-15	Active, successful	2	2	New alternate
Snake River Butte	18-IC-16	Active, successful	1	1	
Buffalo River	18-IC-17	Active, unsuccessful	0	0	New territory

Summary Statistics

Total number nesting territories	39	Advanced young/occupied nest: 1.13 (43/38)
Number occupied territories	38	
Number active territories	36	Advanced young/active nest: 1.19 (43/36)
Number successful territories	30	
Number advanced young	43	Advanced young/successful nest: 1.43 (43/30)

Bald Eagle Habitat Observations

Threats to the productivity of bald eagles at several individual breeding areas have increased dramatically in the last few years. Development proposals now being implemented may eliminate bald eagle use of the King Creek, Palisades Creek, Swan Valley, Box Canyon, and I. P. Bills territories within the next few years. Many other breeding areas are experiencing increasing levels of human activity.

Several of the newer Southeast Idaho pairs have exhibited much more resilience to nest site disturbance than anticipated, but now we may be witnessing examples of the longer-term effects of such disturbance. Thelander (1973) documented bald eagle reactions to incrementally increased human activity around a lake in California. Nesting pairs responded by gradually moving their nesting activity farther from the lakeshore. The Cress Creek pair on the South Fork will be interesting to monitor in 1995 as they seek out a new nest site. The old nest, which blew out of the tree in 1994, had in the last few years become the site of considerable disturbance early in the nesting season. This pair's choice of a new site will signal the degree of disturbance that new pair's will tolerate over the long-term.

Bald Eagle Key Use Areas

We provide preliminary information on three bald eagle breeding areas for use in breeding area management planning. We have not conducted intensive observations within these areas, and cannot provide a complete picture of foraging area and home range zones. We provide baseline information only, including: breeding area nesting chronology and past productivity, occupied nesting zones for each breeding area, known foraging and perching areas, and comments on breeding area habitat quality.

Wolverine Creek (18-IS-10)

Breeding Area History. The Wolverine Breeding Area was first occupied in 1992. Prior to that year, adult bald eagles with young were often seen within the breeding area, but eventually it was determined that these young were produced elsewhere. Adults from the Gormer Canyon Breeding Area were observed foraging near Wolverine Creek in 1990 and visually tracked back to the Gormer nest. Some young of the year seen in the area in mid-summer were fledged from Wyoming nest sites as indicated by bands.

The first nesting attempt in the Wolverine area occurred in 1992. On March 12, S. Austin of the Idaho Bald Eagle Research Project saw a bald eagle on a built-up heron nest 0.5 miles south of Wolverine Creek, at the north end of the Great Blue Heron rookery near the east river road (figure 2). An adult was stationary in incubation posture for approximately one hour before it left the nest to soar with another adult. The nest was left unattended for 45 minutes before an adult returned to incubate. B. Alford and others saw an adult in incubation posture in March and early April. K. Aslett reported an incubating adult on April 13, but on April 14, M. Whitfield saw no adults on the nest. Both adults were perched in nearby trees. These behaviors suggest that this was a new pair in its first nesting attempt. The 1992 nesting attempt failed early.

Since 1992, the Wolverine pair, probably the same pair that nested in the heron rookery in 1992, has successfully nested in a large Douglas fir on the west canyon rim opposite Mud Creek. Nest number two for the area is .3 mile upriver of the original nest. Two young were produced here in 1993, one in 1994. Observations in 1993 and 1994 indicate that this pair initiates incubation relatively early, sometime in the first week of March or end of February.

Occupied Nesting Zone, Zone 1. We describe an occupied nesting zone and key use areas in figure 2. This zone includes only nest site #2 for the territory. The initial 1992 nest (#1) was built in early spring before human activity intensified along the South Fork road, and was abandoned early. It does not appear that this nest site is tenable as a productive bald eagle nest, nor that it should be protected under Zone 1 guidelines.

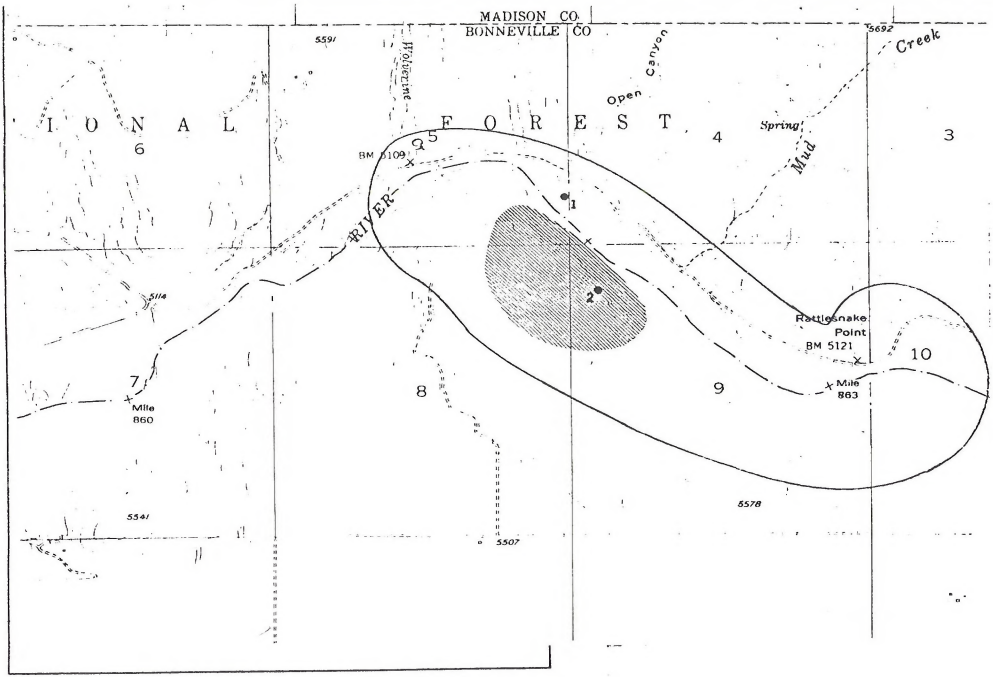


Figure 2. The Occupied Nesting Zone (Zone 1) and known key use areas within the Wolverine Bald Eagle Breeding Territory, 1994. No intensive monitoring has occurred at this breeding area, and the information portrayed is preliminary only. Numbers indicate known nests, lined area is Zone 1, and red line encloses PMP.

Table 5. Known productivity at the Wolverine Creek bald eagle breeding territory since re-establishment of nesting pairs on the South Fork Snake River.[1]

YEAR	NESTING STATUS	NUMBER YOUNG FLEDGED	NEST NUMBER	COMMENT
1992	Active, Unsuccessful	0	Nest #1	Failed 4/14, no young seen.
1993	Active, Successful	2	Nest #2	Discovered 7/7
1994	Active, Successful	1	Nest #2	Banded 5/28

1 Productivity data from 1992-present from agency reports and reports compiled by M. Whitfield et. al.

We define Zone 1 from the responses of nesting adults during banding and observation attempts at nest #2. This pair does not react to human activity around nest #1.

Key Use Areas. A favored Wolverine pair foraging area is the river section opposite Rattlesnake Point. The Wolverine adults are often seen in Douglas-fir perches on the south side of the river in this reach, and prey captures have been seen here. Other frequently used perches include a large snag about 75m upriver of the nest tree, and several snag and live Douglas fir perches downstream opposite Wolverine Creek. We have not tracked this pair enough to be aware of other key use areas.

Cress Creek (18-IS-12)

Breeding Area History. This territory was initially occupied in spring 1988. The adult pair caused some concern when it built and incubated on a cottonwood nest near the planned path of a new power line (B. Jones pers. comm.). The power line was subsequently shifted down river slightly from the planned line, and the pair has continued to occupy the same nest since 1988. This nest is highly visible from a road across the river, and is also near a popular area for bank fisherpersons (opposite bank). The pair is more tolerant of human activity than most pairs on the South Fork. The adult male of this pair is banded with a Fish and Wildlife Service band, but numbers have not been read because the band is tarnished.

This pair has typically begun to incubate relatively early, usually in late February or early March, as indicated by early season observations and estimated age of young at banding (Table 6). However, in 1993 and 1994, incubation started about one week later.

This pair was consistently successful at producing young from 1998 to 1992, usually two young each year (Table 6). However, the nest failed in 1993 and blew down with an unknown number of young in 1994.

This pair has produced 1 color morph nestling in 3 of 5 years since establishment of the territory. One of these color morph young, a 1990 male fledgling, was seen repeatedly in the company of an adult female near the Teton Creek nest in Teton Valley in spring, 1991. This nesting attempt did not advance beyond initial construction. Another, apparently the color morph banded in 1988, nested and produced young on the Upper Teton River Territory (18-IS-21) in 1994.

Occupied Nesting Zone, Zone 1. Our banding forays into the Cress Creek nest area allow us to define a zone of adult tolerance for human activity around the nest (figure 3).

Key Use Areas. We have monitored this pair for several extended periods since 1990, although observations total only about 40 hours. In these limited observations, the pair focused upon the river reaches from the railroad trestle to 1/2 km below the Heise Bridge. Highly used fishing perches were in the islands downriver of the nest,

Table 6. Estimated nesting chronology within the Cress Creek bald eagle breeding territory, South Fork Snake River, 1989 to 1994.

YEAR	APPROXIMATE DATES INITIATION OF INCUBATION	HATCHING	DATE YOUNG FIRST SEEN	DATE AND ESTIMATED AGE AT BANDING	COMMENTS
1989	03/01/89	04/02/89	04/16/89	06/02/89 8 weeks	
1990	03/01/90	04/02/90	04/18/90	05/28/90 7.5 weeks	
1991	02/24/91	03/29/91	04/05/91	05/25/91 8 weeks	
1992	02/27/92	04/02/92	04/14/92	05/17/92 6.5 weeks	
1993	03/09/93	04/13/93	Failed early		
1994	03/07/94	04/10/94	Young not seen	Blowdown 5/28	

Table 7. Known productivity at the Cress Creek bald eagle breeding territory since re-establishment of nesting pairs on the South Fork Snake River.[1]

YEAR	NESTING STATUS	NUMBER YOUNG FLEDGED	NEST NUMBER	COMMENT
1988	Active, Successful	2	Nest #1	New territory, banded, 1 color morph
1989	Active, Successful	1	Nest #1	Banded
1990	Active, Successful	2	Nest #1	Both banded, 1 color morph
1991	Active, Successful	2	Nest #1	Banded 1, 1 color morph not banded
1992	Active, Successful	2	Nest #1	Banded, no color morphs
1993	Active, Unsuccessful	0	Nest #1	Failed early
1994	Active, Unsuccessful	0	Nest #1	Nest blowdown, young killed.

[1] Productivity data from 1988-present from agency reports and reports compiled by M. Whitfield et. al.

particularly a cottonwood overlooking a north channel riffle about 200 m below the nest, and several cottonwoods near the nest tree. Sometimes these adults flew west of the river to unknown locations and returned to the nest with prey. They also flew to unknown locations downriver of the railroad trestle.

In recent years, there has been increased human activity in the vicinity of the Cress Creek nest early in the nesting period. Fishermen often park on the dike and fish near the nest. We have observed very noisy fishermen in the river near the nest during incubation. Since blowdown of the original nest in 1994, it would be surprising to see this pair build again in this area of focused disturbance.

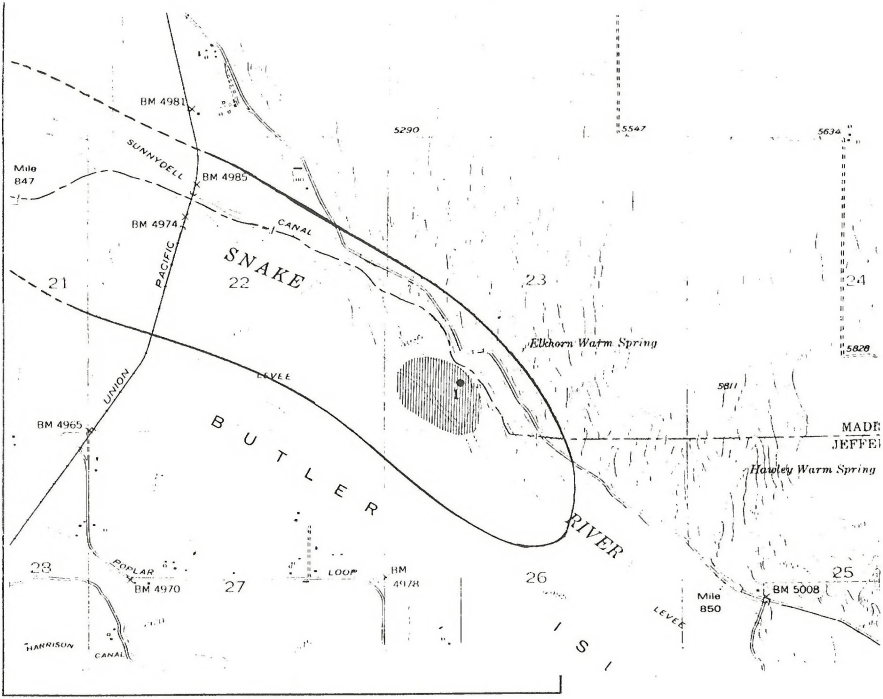


Figure 3. The Occupied Nesting Zone (Zone 1) and known key use areas within the Cress Creek Bald Eagle Breeding Territory, 1994. Intensive monitoring has not occurred at this breeding area, and the information portrayed is preliminary only. Numbers indicate known nests, lined area is Zone 1, and red line encloses PMP.

Confluence (18-IS-13)

Breeding Area History. The Idaho Department of Fish and Game first reported use of the Confluence nesting area in 1977 (Table 8). Many different nests have been used in subsequent years; the pattern of changing sites has made monitoring of this area confusing. In some years, it appears that use of nearby areas by other bald eagle pairs has been confused with Confluence pair activity. The first use of the Menan Buttes nest in 1990 was initially described as a Confluence pair alternate nest. We have not monitored adult turnover at this site, one factor that may lead to nest changes. Most nests built in this area have fallen after only a few years due to bank erosion or nest tree failure. All of the nests used have been in older cottonwoods, several in dead canopies.

Early season observations in this territory and nestling age at banding suggest that eagles in this vicinity typically initiate nesting around the first of March. For example, R. Jones noted an incubating adult on nest #3 on 3/2/83. J. Gardetto and K. Aslett saw an incubating adult on nest #7 on 3/2/94.

Occupied Nesting Zone, Zone 1. Our initial display of Zone 1 for the Confluence Territory (figure 4) is drawn around all known Confluence alternate nests used from 1979-1994 according to the GYE Bald Eagle Management Plan (1983) guidelines.

Key Use Areas. Although we have few actual observations of Confluence pair movements, we suggest that most key use areas for this pair are contained within the zone 1 boundary. Examination of prey remains suggests that these adults also use the pond and sage covered areas north of the river (figure 4). Prey remains at this nest have been among the most varied of those found at any southeast Idaho nest site, including hares, chubs, suckers, a wild turkey, and several waterfowl species.

Table 8. Known productivity at the Confluence bald eagle breeding area since re-establishment of nesting pairs on the South Fork Snake River.[1]

YEAR	NESTING STATUS	NUMBER YOUNG FLEDGED	NEST NUMBER	COMMENT
1977	Active, Unknown	?	Nest #1	New nest located at Confluence.
1978	Activity unknown	?	Nest #2	
1979	Active, Successful	1	Nest #2	New alternate, probably used in 1978
1980	Active, Successful	1	Nest #3	New nest on island upriver of 1979 nest
1981	Active, Successful	2	Nest #3	
1982	Active, Successful	1	Nest #3	
1983	Active, Successful	2	Nest #3	Banded 1 of 2 young, 1 flew from nest
1984	Occupied, Inactive	0	No nest	Previous nest blew down, no new nest
1985	Active, Successful	2	Nest #4	Nest too hazardous to climb
1986	Active, Successful	1	Nest #4	Nest blew down after fledging
1987	Active, Successful	3	Nest #5	Banded nestlings
1988	Active, Successful	2	Nest #5	Banded nestlings
1989	Active, Successful	1	Nest #5	Banded nestling
1990	Active, Unsuccessful	0	Nest #5	New Menan Buttes successful upriver
1991	Active, Successful	1	Nest #6	New alternate for the year, did not band
1992	Active, Unsuccessful	0	Nest #6	Incubation on 1991 nest
1993	Active, Unsuccessful	0	Nest #7	Adults at built-up redtail nest
1994	Active, Successful	1	Nest #7	New alternate for the year

[1] Productivity data for 1977 from Idaho Department of Fish and Game, Region 6 files, and 1978-present from Bureau of Land Management and Id. F&G reports and reports compiled by M. Whitfield et. al.

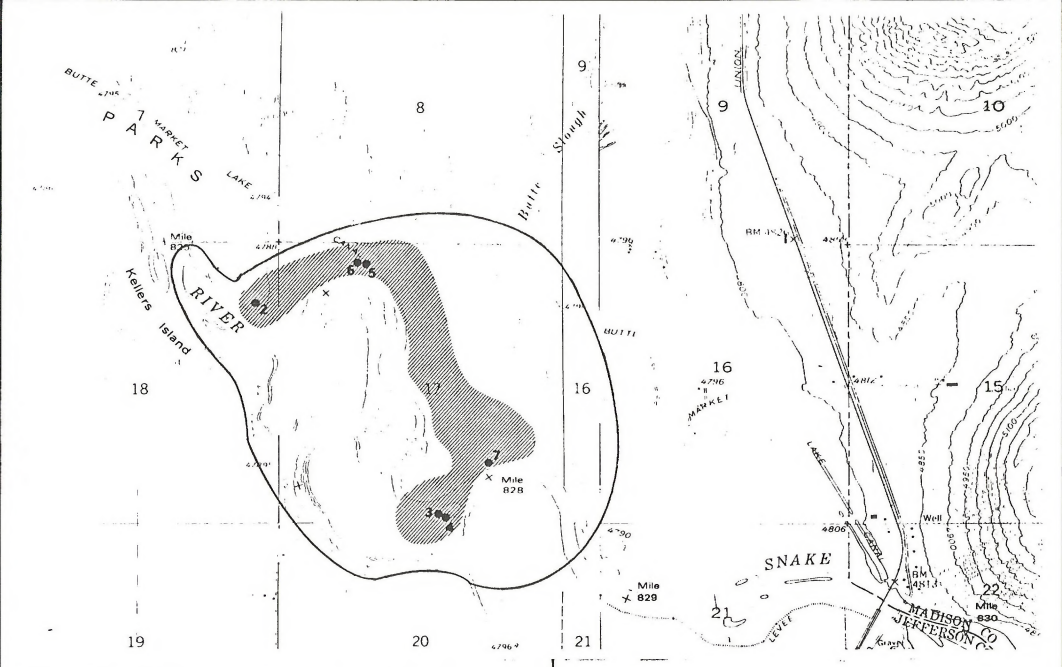


Figure 4. The Occupied Nesting Zone (Zone 1) and known key use areas within the Confluence Bald Eagle Breeding Territory, 1994. Intensive monitoring has not occurred at this breeding area, and the information portrayed is preliminary only. Numbers indicate known nests, lined area is Zone 1, and red line encloses PMP.

Raptor Detection

The primary intent of this project is to detect adult birds that are involved in reproductive behaviors such as territorial calling or defense. Despite years of interest and study, raptors remain difficult to survey (Fuller and Mosher 1981, 1987, Kochert 1986, Smith 1987, Mosher et al. 1990). This survey difficulty arises because raptors are relatively wide ranging, are highly mobile, occur at low densities, and, as is the case with many owls, can be solely nocturnal. Several raptorial species, such as accipiters, are secretive during certain phases of their nesting cycle.

Important summaries of monitoring and survey techniques have been presented (e.g. Call 1978, Fuller and Mosher 1981, 1987, Kochert 1986). Call (1978) focuses on the nesting habitat of raptors found in the Western United States. He describes the nesting habitat of common diurnal and nocturnal raptors and survey methods used, including species specific timing and survey precautions. Call concludes his species accounts with comments on specific behaviors and vocalizations one might encounter at nests.

Fuller and Mosher (1981, 1987) review the most common methods of detecting and counting raptors. They describe three primary applications for raptor surveys: 1) to determine species occurrence, 2) to estimate population numbers, and 3) for specific information on population demographics and reproductive status. The strengths and weaknesses of road and aerial counts, nest searches, roost and colony counts, Christmas Bird and migration counts, and trapping are presented. They encourage more effort in the development of efficient and reliable sampling techniques which can be applied to a diversity of raptors and their habitats. They discuss methods and examples of precision and accuracy for raptor surveys. With the recognition that monitoring resources are limited, they emphasize the need to pool and compare raptor studies.

Kochert (1986) starts with general information on monitoring methods and ends with species specific information on how, when and where to survey. Features of nesting, foraging and winter habitats for 44 Falconiform species are discussed with complete literature sources.

These major works reiterate the importance of knowing the biases associated with each survey method. They identify variables related to observers, working environments, and raptor species surveyed that affect survey reliability. Knowledge of a species' behavior, habitat, seasonal ecology, and highly developed identification skills are all identified as critical and controllable variables.

A number of authors present specific information on the application of individual methods. For example, Mosher et. al. (1990) and Johnson et. al. (1981) discuss broadcast of conspecific vocalizations in the detection of woodland raptors. Broadcast calling with recorded raptor vocalizations can increase the rate at which several species are detected when compared to land surveys (by walking or automobile) where the observer did not attempt to elicit calls (McGarigal and Fraser 1984, Rosenfield et al. 1985).

Nest boxes have been used to collect information on the population demographics of several cavity-nesting species such as kestrels and several of the smaller owls (e.g. see Hayward et. al. 1992 for information on use of nest boxes to learn demographic information on boreal owls).

We discuss species-specific detection methods in raptor species accounts below, and summarize this information in Appendix A, tables 2 and 3.

Raptor Occurrence, Presence or Absence

We individually sampled 16 quadrats within each of 19 randomly selected square mile sections (Table 9 and figure 5). Our sampling was incomplete at several sites because of access difficulties corrected late in the season; sampling in these areas must be completed in 1995. We report findings of these surveys in Appendix Table 5 and under the section headed Local Occurrence for each raptor species. We will revisit each of these sample areas in 1995 in combination with the new sample areas selected.

The 1994 presence/absence sampling revealed two prominent results that will be quantified in our more intensive sampling in 1995. First, much of the potential raptor habitat within the Snake River corridor, defined here as the area within one mile of the river, has been altered to the extent that its capacity to support raptors is low. For example, approximately 1/3 of the area is in cultivated cropland, and conversion of forest cover to cropland is ongoing (e.g Sec. 26 in the Cress Creek area). Secondly, raptor density appears to be lower in many areas than anticipated, and more clumped in others. This result may be further evidence of habitat alteration within the study area.

Table 9. Randomly selected sample areas for determination of raptor occurrence in 1994. All sample areas are mapped, legal, square mile sections. All 40 acre quadrats (1/4 of 1/4 sections) were sampled individually.

River Segment	Section	Comments
1	Sec. 7; T1S; R45E	Gravel pit and forest down river of dam
1	Sec. 27;T1N; R44E	Irwin cemetery
2	Sec. 11;T1N; R43E	Fall Creek campground area
2	Sec. 30;T2N; R43E	Conant Valley
2	Sec. 21;T2N; R43E	Pine Creek
3	Sec. 6; T2N; R43E	Upriver of Dry Canyon
3	Sec. 23; T3N; R42E	West of Lufkin bottom
3	Sec. 13; T3N; R42E	Black Canyon
4	Sec. 15; T3N; R41E	Clark Hill
5	Sec. 26; T4N; R40E	Cress Creek area
6	Sec. 35; T5N; R39E	Texas Slough
7	Sec. 13; T5N; R38E	Annis rookery area
7	Sec. 17; T5N; R38E	Confluence PMP area
7	Sec. 18; T5N; R38E	Keller's Island
8	Sec. 14; T5N; R37E	Downriver of Deer Parks
8	Sec. 22; T5N; R37E	Mile 821, downriver of Deer Parks
9	Sec. 35; T5N; R37E	Downriver of Big Six Canal area
11	Sec. 33; T7N; R39E	Warm Slough near Hibbard Bridge
11	Sec. 19; T7N; R40E	Downriver of old Ft. Henry

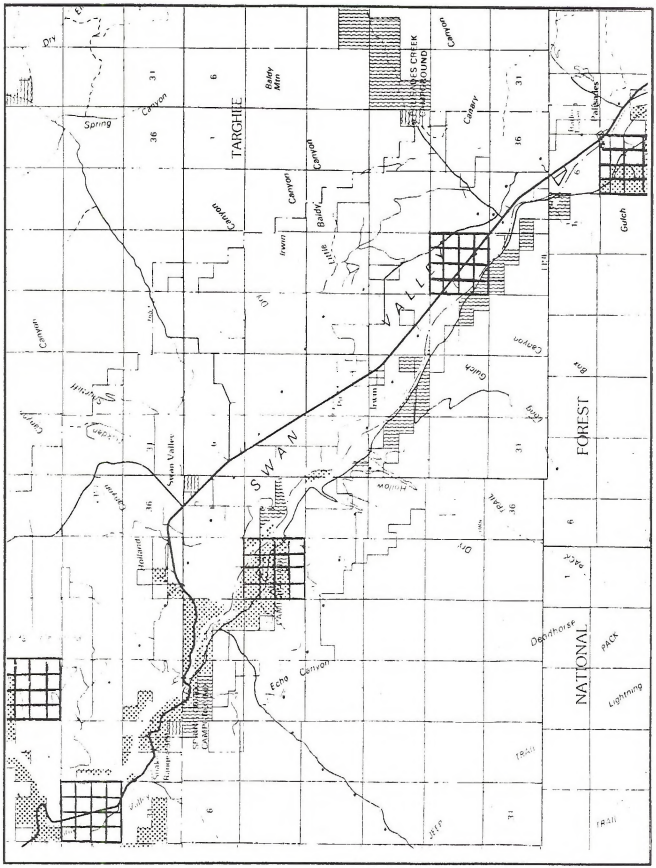


Figure 5a. Map of square mile sections sampled in Swan Valley area for raptor occurrence and vegetative cover types in 1994 (Scale 1:24,000).

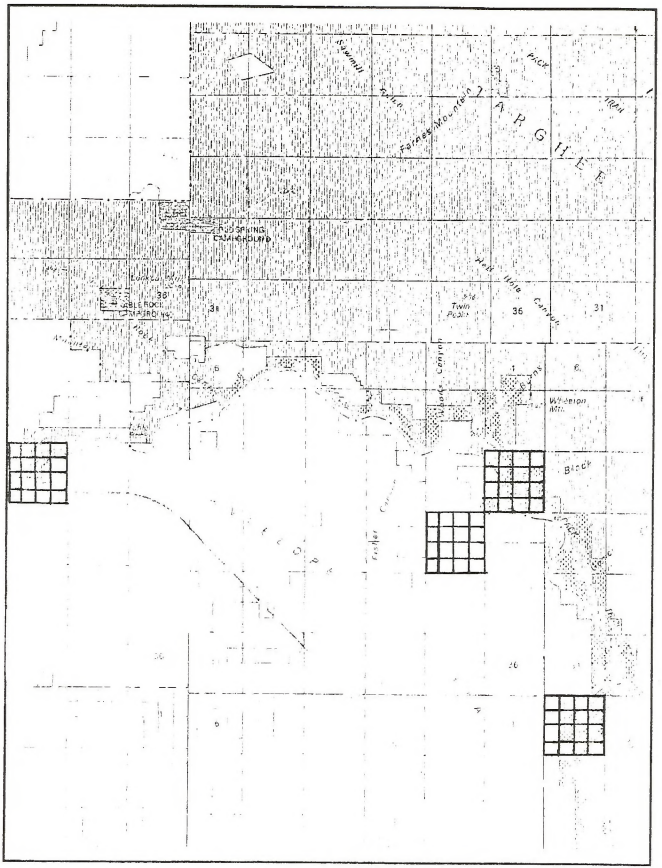


Figure 5b. Map of square mile sections sampled in South Fork Canyon area for raptor occurrence and vegetative cover types in 1994 (Scale 1:24,000).

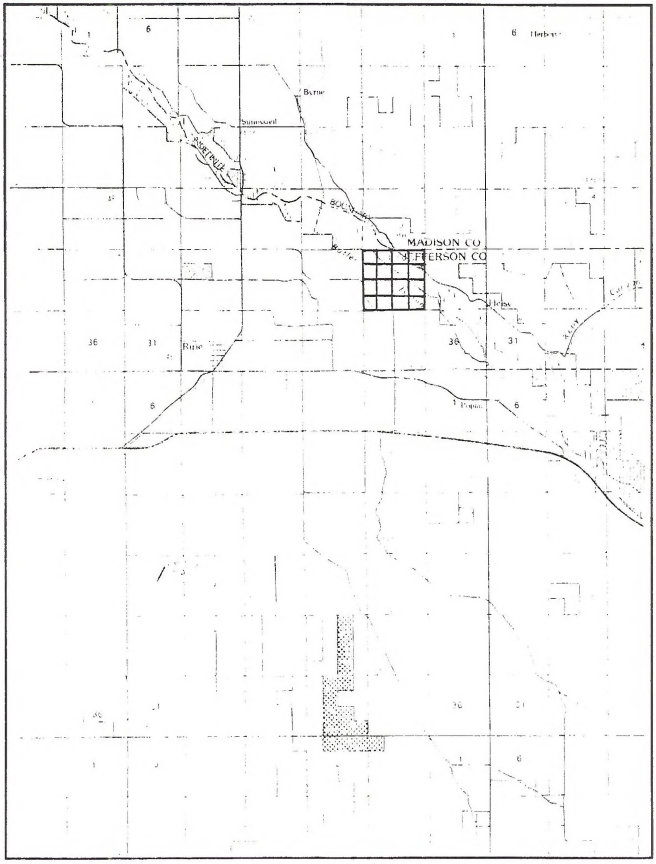


Figure 5c. Map of square mile sections sampled in Heise to Sunnydell portion of the study area for raptor occurrence and vegetative cover types in 1994 (Scale 1:24,000).

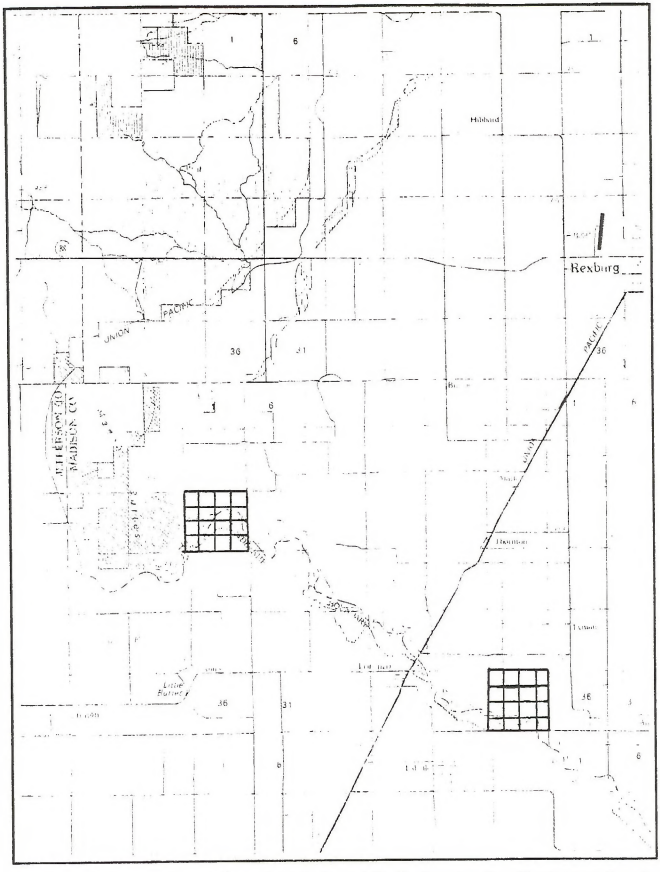


Figure 5d. Map of square mile sections sampled in the Sunnydell to Confluence portion of the study area for raptor occurrence and vegetative cover types in 1994 (Scale 1:24,000).

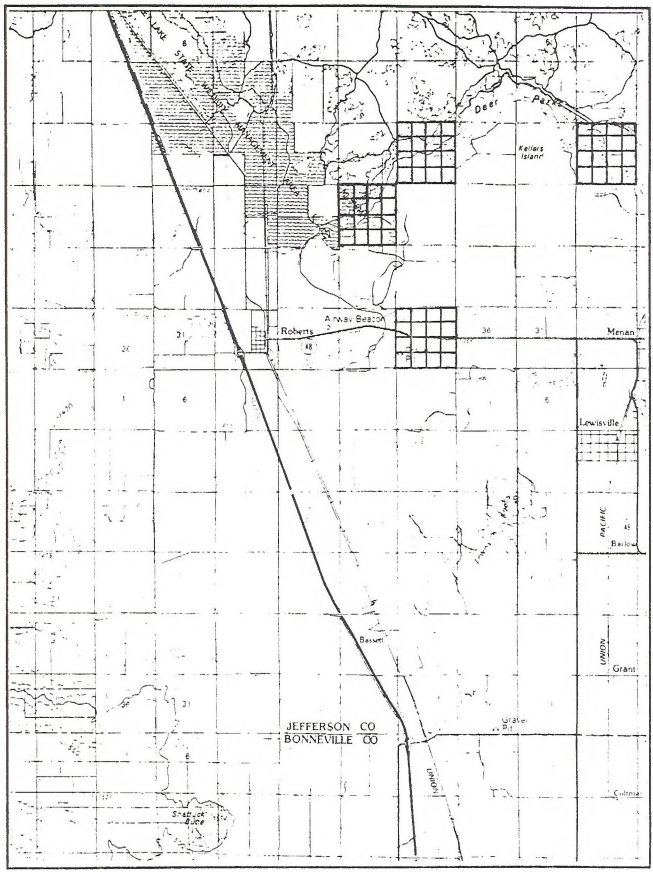


Figure 5e. Map of square mile sections sampled in the Confluence to Roberts portion of the study area for raptor occurrence and vegetative cover types in 1994 (Scale 1:24,000).

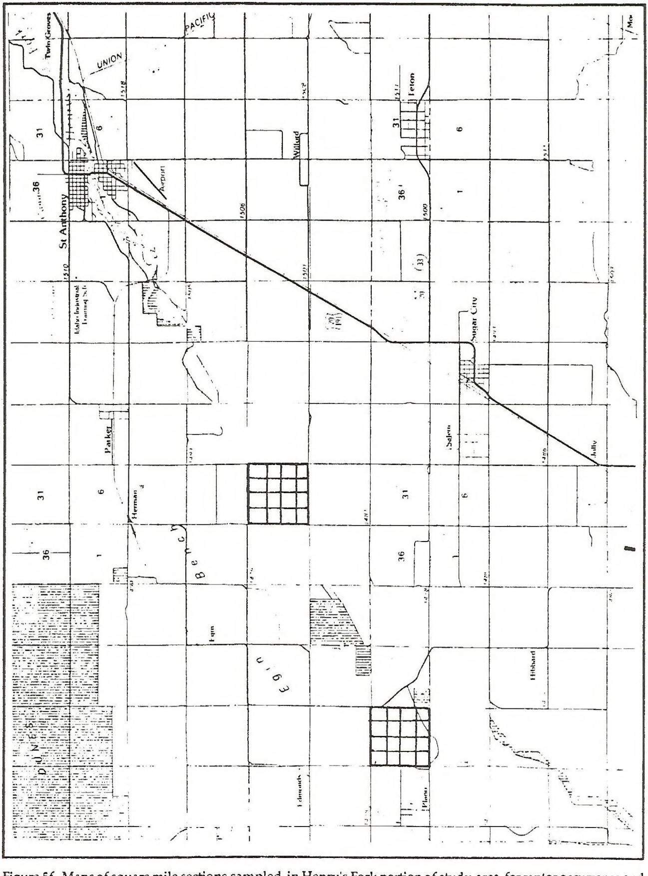


Figure 5f. Maps of square mile sections sampled in Henry's Fork portion of study area for raptor occurrence and vegetative cover types in 1994 (Scale 1:24,000).

Appendix Table 2. Summary of inventory information for diurnal raptor species suspected within Snake River study area.

Species	Occurrence[1]	General Habitats	Appropriate Survey Methods
Bald Eagle	Known, this study	Stick nests. Cottonwood riparian and Douglas fir.	Aerial and ground surveys.
Golden Eagle	Known, this study	Stick nests. Cliff ledges.	Aerial and ground surveys. Fledgling food-begging calls.
Osprey	Known, this study	Large stick nests up to 3 mi. from river.	Aerial, ground surveys.
Northern Goshawk	Known, this study	Mature conifer, mixed deciduous. Stick nests.	Calls 5/1-6/30. Fledgling food-begging calls, 7/1-8/15.
Cooper's Hawk	Known, this study	Riparian woodlands, mixed conifers. Stick nests.	Same protocol as for goshawks
Sharp-shinned Hawk	Known this study	Dense even-aged conifer stands of smaller diameter. Stick nests.	Same protocol as for goshawks
Red-tailed Hawk	Known, this study	Open tree stands, Stick nests.	Broadcast calls 3/20-5/15.Fledgling food-begging calls, 7/1-8/15. Ground and aerial surveysbefore leaf-out.
Swainson's Hawk	Known, this study	Pastures, shrublands and open meadows. Stick nest	Ground surveys 5/1-8/15.
Feruginous Hawk	Potential	Sagebrush grasslands, Open country, ground nests	Ground surveys, March courtship Mid-April, conspicuous young on nests.
Northern Harrier	Known. this study	Grasslands and riparian shrub. Ground nests	Systematic ground surveys for May courtship, extended observation to track prey delivery to nests.
Peregrine Falcon	Known this study	Big walls, cliffs near riparian	Ground survey March courtship, July fledge.
Prairie Falcon	Known this study	Rock cliffs, near river to semi-arid areas	Ground survey March courtship, July fledge, BLM protocol
Merlin	Potential	Open forest near grasslands	Ground surveys April courtship, young call in July
American Kestrel	Known this study	Secondary cavity in deciduous forest	Systematic ground surveys (E. Bull protocol)
Turkey Vulture	Known this study	Cliffs, caves, dense shrubs. Grasslands and conifer edge.	Systematic ground surveys

[1] Terms used here for occurrence include: known, this study = nest sites and/or territorial adults seen or heard; known, reports = listed as a species found in this area; suspected, appropriate habitat for these species found in the area; potential, may be found here but marginally.

Appendix Table 3. Summary of inventory information for owl species suspected within Snake River study area.

Species	Occurrence[1]	General Habitats	Appropriate Survey Methods
Saw-Whet Owl	Known, this study	Cavities, mixed conifers, cottonwoods.	Territorial calls 2/15-4/30. Fledgling food-begging calls.
Northern Pygmy Owl	Known, this study	Cavity nest. Spruce/fir and Douglas fir.	Calls 4/1-5/30 & 9/1-11/1.
Western Screech Owl	Known, this study	Cavity nest. Mature riparian, deciduous or Douglas fir to aspen.	Territorial calls 2/1-4/30. Fledgling food-begging calls.
Flammulated Owl	Known, this study	Cavity nest. Mature conifer, aspen.	Territorial calls 5/1-6/30. Fledgling food-begging calls.
Short-eared Owl	Suspected	Ground nests. Grasslands and marshes at forest edge.	Territorial calls 3/1-5/1. Ground surveys. Fledgling calls, diurnal flights.
Long-eared Owl	Known, this study	Stick nest. Mixed fir and cottonwoods.	Territorial calls 3/1-4/15
Great Horned Owl	Known this study	Stick nest. Across all habitats.	Territorial calls 1/1-5/1. Ground surveys. Fledgling calls.
Great Gray Owl	Potentiall	Broken top tree or stick nest. Lodgepole and Douglas fir, spruce. Open canopy forest.	Territorial calls 2/1-4/1. Fledgling food-begging calls.
Barred Owl	Potential	Cavity or stick nest. Mixed fir. Deciduous forests in east.	Territorial calls 3/1-4/1.
Boreal Owl	Potential	Cavity nest. Mature spruce/fir. Higher elevation (marginal here).	Territorial calls 2/15-4/30. Fledgling food-begging calls.
Burrowing Owl	Potential	Burrow, Flat pasture land	Ground surveys. Territorial calls 4/1-6/15.

[1] Terms used here for occurrence include: known, this study = nest sites and/or territorial adults seen or heard; known, reports = listed as a species found in this area; suspected, appropriate habitat for these species found in the area; potential, may be found here but marginally.

Appendix Table 4. Raptor breeding area report form.

Nest/Territory/Occurrence Number Site Number Year Map Name

Area Description UTM-N or Latitude UTM-E or Longitude

Raptor Species Breeding Area Status

Nest surveys:

Date	Time	Method	No. Adults	No. Subadults	N. Eggs	No. Nestlings	No. Fledglings

Observer

Season Summary and Remarks

Nest Tree or Cliff:
Species Character Type Height Diameter Canopy Diameter

Nest Characteristics:
Height Diameter Condition

Habitat Features:
Dominant Type Basal Area Canopy Area

Aspect Slope Elevation

Nearest Human Activity/Distance:
Roads Structures Activity Activity Type Visibility

Banding and Band Recovery:
Age Sex Avise No. Color Code/Leg

Prey Remains:
Dates Items collected

Appendix Table 5. Raptor presence survey results on Snake River Study area, 1994
(each record is of an individual raptor species detected within the quadrat.)

Area or Quadrangle	STR	Quadrant	Raptors detected	Habitat Code	Most prominant Habitat	Secondary or Modification
Palisades	7,1S,44E	9	Bu.vi.	421	421 Douglas-fir forest	
Palisades	7,1S,44E	13	Bu.vi.	421	421 Douglas-fir forest	
Falls C.G.	11,1N,43E	2	Bu.vi.	623	623Cottonwood riparian	
Falls C.G.	11,1N,43E	2	Pa.ha.	623	623Cottonwood riparian	
Falls C.G.	11,1N,43E	2	Ha. le.	623	623Cottonwood riparian	
Falls C.G.	11,1N,43E	3	Ha. le.	623	623Cottonwood riparian	511 River, u. p.
Falls C.G.	11,1N,43E	3	Fa.sp.	623	623Cottonwood riparian	511 River, u. p.
Falls C.G.	11,1N,43E	4	Ha. le.	623	623Cottonwood riparian	511 River, u. p.
Falls C.G.	11,1N,43E	5	Ha. le.	623	623Cottonwood riparian	421 Douglas-fir
Falls C.G.	11,1N,43E	6	Ha. le.	623	623Cottonwood riparian	421 Douglas-fir
Falls C.G.	11,1N,43E	6	Ac.co.	623	623Cottonwood riparian	421 Douglas-fir
Falls C.G.	11,1N,43E	7	Bu.ja.	623	623Cottonwood riparian	421 Douglas-fir
Falls C.G.	11,1N,43E	8	Ae.ac.	421	421 Douglas-fir forest	623Cottonwood
Falls C.G.	11,1N,43E	8	Bu.ja.	421	421 Douglas-fir forest	
Falls C.G.	11,1N,43E	8	Ac.co.	421	421 Douglas-fir forest	
Falls C.G.	11,1N,43E	10	Bu.ja.	421	421 Douglas-fir forest	412 Aspen o.
Conant Valley	30,2N,43E	3	Ha. le.	623	623Cottonwood riparian	212 Pasture
Conant Valley	30,2N,43E	4	Ha. le.	212	212 Pasture	511 River, u. p.
Conant Valley	30,2N,43E	5	Ha. le.	212	212 Pasture	
Conant Valley	30,2N,43E	6	Ha. le.	212	212 Pasture	
Conant Valley	30,2N,43E	11	Ha. le.	623	623Cottonwood riparian	212 Pasture
Conant Valley	30,2N,43E	12	Ha. le.	212	212 Pasture	511 River, u. p.
Conant Valley	30,2N,43E	13	Ha. le.	623	623Cottonwood riparian	
Conant Valley	30,2N,43E	13	Bu. ja.	623	623Cottonwood riparian	
Conant Valley	30,2N,43E	14	Bu. ja.	623	623Cottonwood riparian	141 Roadway
Pine Creek	21,2N,43E	1	Aq. ch.	321	321 Sagebrush	741 Cliff
Pine Creek	21,2N,43E	1	Fa. me.	321	321 Sagebrush	741 Cliff
Pine Creek	21,2N,43E	2	Aq. ch.	321	321 Sagebrush	741 Cliff
Pine Creek	21,2N,43E	4	Bu.ja.	421	421 Douglas fir	741 Cliff
Pine Creek	21,2N,43E	4	Fa.sp.	421	421 Douglas fir	741 Cliff
Pine Creek	21,2N,43E	7	Bu.ja.	421	421 Douglas fir	211 Plowed c.
Wh. Mtn/Dry Car	6,2N,43E	2	Ca.au.	211	211 Plowed cropland	
Wh. Mtn/Dry Car	6,2N,43E	3	Bu.ja	321	321 Sagebrush	511 Upper Pere
Wh. Mtn/Dry Car	6,2N,43E	7	Bu.ja	321	321 Sagebrush	
Wh. Mtn/Dry Car	6,2N,43E	7	Fa.sp.	321	321 Sagebrush	
Wh. Mtn/Dry Car	6,2N,43E	8	Fa.sp.	211	211 Plowed cropland	412 Aspen
Wh. Mtn/Dry Car	6,2N,43E	9	Bu.ja.	211	211 Plowed cropland	412 Aspen
Wh. Mtn/Dry Car	6,2N,43E	10	Ae.ac.	211	211 Plowed cropland	412 Aspen
Wh. Mtn/Dry Car	6,2N,43E	14	Ae.ac.	421	421 Dougls-fir	
Wh. Mtn/Lufkin	23,3N,42E	4	Fa.sp.	623	623 Cottonwood	
Wh. Mtn/Lufkin	23,3N,42E	5	Bu.sw.	211	211 Plowed cropland	623 Cottonwood

Wh. Mtn/Black C	13,3N,42E	11	As.ot.	421	421 Douglas fir	
Wh. Mtn/Black C	13,3N,42E	11	Ac.ge.	421	421 Douglas fir	
Wh. Mtn/Black C	13,3N,42E	12	Bu.ja.	421	421 Douglas fir	
Wh. Mtn/Black C	13,3N,42E	12	Fa.sp.	421	421 Douglas fir	
Wh. Mtn/Black C	13,3N,42E	13	Fa.sp.	322	322 Mtn. Mahogany	
Wh. Mtn/Black C	13,3N,42E	14	Ha.le.	321	321 Sagebrush	
Wh. Mtn/Black C	13,3N,42E	14	Bu.ja.	321	321 Sagebrush	
Wh. Mtn/Black C	13,3N,42E	14	Fa.sp.	321	321 Sagebrush	
Wh. Mtn/Black C	13,3N,42E	15	Bu.ja.	321	321 Sagebrush	
Clark Hill	15,3N,41E	1	Ca.au.	321	321 Sagebrush	741 Cliffs
Clark Hill	15,3N,41E	1	Bu.ja.	321	321 Sagebrush	741 Cliffs
Clark Hill	15,3N,41E	1	Bu.ja.	321	321 Sagebrush	741 Cliffs
Clark Hill	15,3N,41E	2	Bu.ja.	321	321 Sagebrush	741 Cliffs
Clark Hill	15,3N,41E	2	Aq. ch.	321	321 Sagebrush	741 Cliffs
Clark Hill	15,3N,41E	9	Ha. le.	741	741 Cliffs	421 Douglas fir
Cress	26,4N,40E	1	Fa.sp.	623	623 Cottonwood	211 Plowed crop
Cress	26,4N,40E	1	Bu.ja.	623	623 Cottonwood	211 Plowed crop
Cress	26,4N,40E	6	Fa.sp.	623	623 Cottonwood	511 River
Texas Slough	35,T5N,R39E	14	Ca.au.	623	623 Cottonwood	511 River
Texas Slough	35,T5N,R39E	14	Bu.ja.	623	623 Cottonwood	511 River
Texas Slough	35,T5N,R39E	15	Pa. ha.	623	623 Cottonwood	511 River
Confluence	17,T5N,R38E	3	Ha. le.	623	623 Cottonwood	212 Pasture
Confluence	17,T5N,R38E	11	Ha. le.	623	623 Cottonwood	511 River
Deer Parks	14,5N,37E	1	Ci.cy.	321	321 Sagebrush	
Deer Parks	14,5N,37E	2	Ci.cy.	321	321 Sagebrush	
Deer Parks	14,5N,37E	4	Bu.vi.	623	623 Cottonwood	
Deer Parks	14,5N,37E	7	Fa.sp.	623	623 Cottonwood	621 Willow
Deer Parks	14,5N,37E	7	Bu.ja	623	623 Cottonwood	621 Willow
Deer Parks	14,5N,37E	8	Bu.sw.	623	623 Cottonwood	621 Willow
Deer Parks	14,5N,37E	8	Fa.sp.	623	623 Cottonwood	621 Willow
Lewisville	22,5N,37E	4	Bu.ja.	623	623 Cottonwood	621 Willow
Lewisville	22,5N,37E	4	Bu.sw.	623	623 Cottonwood	621 Willow
Lewisville	22,5N,37E	6	Fa.sp.	623	623 Cottonwood	621 Willow
Lewisville	22,5N,37E	10	Ha.le.	623	623 Cottonwood	621 Willow
Lewisville	22,5N,37E	10	Fa.sp.	623	623 Cottonwood	621 Willow
Lewisville	22,5N,37E	11	Ha.le.	623	623 Cottonwood	621 Willow

Appendix Table 6. Band numbers, locations and dates for nestling bald eagles banded within the Idaho portion of the Greater Yellowstone Ecosystem, 1994.

USFWS BAND NUMBER	COLOR BAND	TERRITORY NAME	TERRITORY NUMBER	DATE BANDED	APPROX. AGE
629-37628	W/G, 0/A	Palisades Cr.	18-IS-04	05/23/94	6.5 weeks
629-37629	W/G, 0/B	Palisades Cr.	18-IS-04	05/23/94	6.5 weeks
629-37630	W/G, 0/C	Conant Valley	18-IS-06	05/23/94	6.5 weeks
629-37631	W/G, 0/D	Conant Valley	18-IS-06	05/23/94	7.0 weeks
629-37632	W/G, 0/E	Market Lake	18-IS-22	05/26/94	5.5 weeks
629-37633	W/G, 0/G	Wolverine	18-IS-10	05/28/94	7.0 weeks
629-37634	W/G, 0/H	Gormer Can.	18-IS-09	05/28/94	5.5 weeks
629-37635	W/G, 0/K	Gormer Can.	18-IS-09	05/28/94	5.5 weeks
629-37636	G/W, 2/R	Hale Creek	18-IC-10	06/07/94	7.0 weeks
629-37637	W/G, 0/M	Hoffman	18-IS-01	06/12/94	7.0 weeks
629-37638	W/G, 0/N	Hoffman	18-IS-01	06/12/94	6.5 weeks
629-37639	W/G, 0/P	King Creek	18-IS-18	06/12/94	7.5 weeks
629-37640	W/G, 0/R	King Creek	18-IS-18	06/12/94	7.5 weeks
629-37641	W/G, 0/S	Williams Cr.	18-IS-02	06/17/94	7.5 weeks
629-37642	G/W, 2/P	Flat Rock	18-IC-14	06/14/94	7.5 weeks
629-37643	G/W, 2/S	Lucky Dog	18-IC-07	06/14/94	6.0 weeks
629-37644	G/W, 2/T	Lucky Dog	18-IC-07	06/14/94	6.5 weeks
629-37645	G/W, 2/U	Riverside	18-IC-15	06/15/94	7.5 weeks
629-37646	G/W, 2/V	Riverside	18-IC-15	06/15/94	7.5 weeks
629-37647	G/W, 2/W	Last Chance	18-IC-12	06/16/94	8.0 weeks
629-37648	G/W, 2/X	Last Chance	18-IC-12	06/16/94	8.0 weeks
629-37649	G/W, 2/Y	Box Canyon	18-IC-03	06/16/94	7.0 weeks
629-37650	W/G, 0/T	Van Point	18-IS-03	06/17/94	6.0 weeks
629-40551	W/G, 0/U	Van Point	18-IS-03	06/17/94	6.5 weeks
629-40558	G/W, 3/G	I.P. Bills	18-IC-13	06/21/94	7.5 weeks
629-40552	G/W, 2/Z	Moonshine	18-IC-11	06/21/94	6.5 weeks
629-40555	G/W, 3/D	Targhee Cr.	18-IC-09	06/25/94	9.0 weeks
629-40556	G/W, 3/C	Targhee Cr.	18-IC-09	06/25/94	8.5 weeks

Species Accounts

We provide a literature review account of overall range and status and currently known local information on the occurrence, productivity and habitat use for each species of raptor which occurs in the Snake River study area. In addition, we provide an account of species-specific detection methods.

Bald Eagle (*Haliaeetus leucocephalus*)

Bald eagles were once widespread throughout North America, but were extirpated from much of their historical range over the past century by habitat loss and direct, human induced mortality (Lincer et al. 1979). Today the Greater Yellowstone Ecosystem supports one of the larger breeding bald eagle populations in the Northern Rockies, with over 90 breeding pairs in the tri-state area around Yellowstone National Park (Swenson et al. 1986, Greater Yellowstone Bald Eagle Working Group 1994). The bald eagle is federally listed as an endangered species in the region of Idaho and Wyoming, and as an endangered species by both states. However, dramatic population recovery in most areas of the United States, including Greater Yellowstone, has led management agencies to promote downlisting to threatened status.

Local Occurrence

Bald eagles of the Greater Yellowstone Ecosystem have recovered dramatically from historic low levels in the 1950s and 1960s. Most of this recovery followed cessation of DDT use in the region (Swenson et al. 1986). Today, Southeast Idaho's 39 active bald eagle nesting territories, 14 in the smaller study area, are among the most productive in the region (Whitfield et al. 1994).

Bald eagles may be seen within the entire study area, particularly along the river margins, during some portion of the year. Nests occur within 3 of the raptor sample areas. Bald eagles may forage within every sample unit, and were seen in multiple quadrats within six sample sections.

Reproductive Biology

Bald eagles on the Southeast Idaho begin nesting in late February to late March (Whitfield 1993). Incubation lasts for about 32-35 days (Herrick 1932), with fledging at about 10-12 weeks after hatching (Stalmaster 1987). Young immatures may remain in the vicinity of the nest up to 6-8 weeks after fledging before migration to winter areas outside the region (Whitfield 1993). Between 1988-1994 in southeast Idaho, advanced young/occupied nest averaged at 1.31, although productivity dipped to a low of 0.69 advanced young/occupied nest in the cold wet spring of 1993 (Whitfield et al. 1994).

Ecology and Habitat Relationships

Bald eagles typically nest, perch, and hunt along major waterways. They require habitats that offer a diverse and abundant prey base, relative freedom from disturbance, particularly in nesting areas, and trees of suitable size for nesting, perching and roosting (Greater Yellowstone Bald Eagle Working Group 1983). Suitable habitat in the study area is found along the South Fork and Henry's Fork of the Snake River. The confluences of major tributaries are often favored nesting and foraging areas.

Bald eagles require large trees to support their heavy nest structures. Bald eagles will nest on artificial support structures placed in conifer or cottonwood trees for their use; bald eagles have nested on five such structures that we have placed in existing southeast Idaho nesting areas. In Southeast Idaho, most bald eagle nests are in cottonwoods and Douglas-fir, with one nest in an aspen. Nesting areas must also offer relative freedom from human disturbance within at least the first two months of the long nesting season. Bald eagles in Southeast Idaho forage upon a variety of prey items, but fish are by far the predominant prey taken (Whitfield et al. 1991, Whitfield 1993).

Winter bald eagle habitat is dependent upon healthy fish and waterfowl populations and secure perches and roosts. An important communal winter roost is known in the Deer Parks area (J. Gardetto pers. comm.).

Detection Methods

Bald eagles typically build very large stick nests in the largest trees available within proximity of foraging habitat. These nests are usually very visible, particularly those in cottonwoods. However, some conifer window nests can be difficult to detect when in forested areas far from water. Surveys for new bald eagle nests are best done by a combination of aerial and ground surveys to detect nests.

Bald eagle vocalizations can lead observers to new nest sites. Adults are very vocally defensive within the vicinity of nest sites, usually when people on the ground approach within 1/4 mile of an active nest, and sometimes at much greater distances (Whitfield et al. 1991). A less intrusive, but more time consuming means of locating new nests is to visually track foraging adults from foraging areas back to nest sites with spotting scopes.

Golden eagle (*Aquila chrysaetos*)

Golden eagles occupy nearly all habitats in western North America, including desert grasslands to above timberline (Johnsgard 1990). Locally we find goldens along the Snake River in cliffs to high in the mountains above timberline. This species prefers hilly or mountainous country where takeoff and soaring are enhanced by updrafts, and open country for hunting. The golden eagle does not have any specific state or federal status in the United States; it is protected under the Eagle Protection Act of 1956.

Local Occurrence

Breeding densities are relatively low everywhere that the species is found, with breeding pair densities of from 26 to 32 square miles per pair in suitable habitat (Smith and Murphy 1973). We are aware of five golden eagle eyries within the study area, all within the canyon segment of the South Fork. All of the known nest sites are on ledges in cliff faces. We saw golden eagles in two of the 1994 sample sections. Golden eagles are common winter residents of the entire study area.

Reproductive Biology

Egg laying could be expected in this area from mid-March to mid-April (Steenhof et al. 1991). Typical clutch sizes average about 2 eggs/nest (McGahan 1968, Beecham and Kochert 1975). Incubation is relatively long in this species, with a minimum of 41 days (Hobbie and Cade 1962). Nestlings fledge at about 72-84 days, and may remain with the adults for 11 weeks or longer (Hobbie and Cade 1962).

Ecology and Habitat Relationships

Golden eagles forage over open fields and dry pasture lands. Nesting typically occurs in cliffs around this region (e.g. South Fork of the Snake River). Historically, direct loss through trapping, shooting and poisoning has occurred throughout the western United States. Repeated human disturbance at nest sites and habitat modification are significant current impacts to the golden eagle. This mortality is directly tied to the perception of this species as a significant predator of domestic livestock. Predation upon livestock by golden eagles can be significant in some situations (Matchett and O'Gara 1987). In some localized areas, golden eagles have incurred significant losses from electrocution on powerlines (Phillips 1985). Nest disturbance may be a leading cause of golden eagle declines in some areas (Scott 1985).

Detection Methods

Given their large size, golden eagle nests are relatively easy to survey from the ground or the air. Large woody nests and whitewash ex-

crement on rock escarpments are good visual indicators of nesting golden eagles. Because of the openness of golden eagle country, nests may be detected in any season. Nests are typically found on cliffs, and secondarily in trees (cottonwoods and Douglas-fir), on the ground or on man-made structures (Call 1978, Kochert 1987, Johnsgard 1990). All golden eagle nests located within the study area have been located on rock cliffs or escarpments within sage/juniper habitat types on south facing slopes. Occupancy should be monitored annually since golden eagles will build and use alternate nests. Occupancy surveys can be initiated during courtship and the nest building phases which start around February in southeastern Idaho.

Osprey (*Pandion haliaetus*)

The osprey is one of the more cosmopolitan and adaptable of the birds of prey. Osprey breed in North America, Europe, northern Asia, Australia and many islands to the north and east, and migrate to all other continents but Antarctica in winter (Poole 1989). The Greater Yellowstone Ecosystem features notably large osprey populations, but mostly around natural lakes and reservoirs rather than rivers (Swenson 1979, 1981). In the 1950s and 1960s, DDT caused osprey population declines in much of North America that persisted into the early 1980s (Henny 1986), but today the osprey is successful in most of its range. Greater Yellowstone populations appear to be expanding.

Local Occurrence

Numerous osprey nests are located along the lower Henry's Fork within the study area. Many of these pairs nest upon artificial structures placed specifically for their use. Fewer pairs are found along the South Fork, primarily in the lower reaches. Osprey have been more frequently seen within the canyon segment of the South Fork in recent years, with a suspected nest site in the Conant Valley area and another in the Stinking Springs area. Historic nest sites were found near the mouth of Falls Creek on the South Fork. Palisades Reservoir features approximately 25 active nest sites annually, with osprey from the reservoir often seen over the South Fork below Palisades Dam. We detected opsprey in two sample sections.

It appears that the primary indicator of osprey habitat within the study area is the proximity of fishable water. Osprey are found historically or currently nesting within Douglas fir, on train trestles and bridges, and numerous artificial structures within the cottonwood forests of the lower river.

Reproductive Biology

Osprey typically return from southern winter ranges to this locale in early April, with an incubation period of approximately 39 days. Clutch sizes for a 3-year study of an expanding osprey population in central Idaho averaged at 2.58 eggs/nest (Van Daele et al. 1980), with an average of 2.0 young/successful nest for 96 successful nesting attempts. Swenson (1975) found an average clutch size of 2.23 eggs and brood size of 1.55 young for Yellowstone Lake's stable population.

Ecology and Habitat Relationships

Osprey forage almost exclusively on fish (Poole 1989). Thus, nest sites and perches are most often associated with water bodies, although nest sites may be several miles from water. Nests are built upon almost any structure that will support a large pile of stick material. Osprey are notably tolerant of human activity and structures. They are disturbed, however, by activities that are directly threatening.

Detection Methods

As with golden and bald eagles, the size and location of osprey nests make this species relatively easy to census and monitor. The tendency to nest on the top of broken topped trees, man-made structures (including telephone poles)

or rock pinnacles, enhances the delectability of nests. Both aerial and ground surveys can be used in censusing. Survey priorities are along waterways, lakes and reservoirs and secondarily up to 3 miles from water where osprey may occasionally select nest sites. Though osprey have a strong fidelity to historic nest sites, nests are occasionally usurped by other species and should thus be surveyed annually for occupancy.

Turkey Vulture (*Cathartes aura*)

The turkey vulture is migratory throughout much of it's range, which is most of the United States at about 50 degrees latitude (Jackson 1983). Turkey vultures breed from Canada to southern South America, and from the east to the west coasts of North America. The distribution of the turkey vulture in the western United States is thought to have remained the same from historic to current times. Turkey vultures are commonly seen soaring around human residents which gives the impression that this scavenging bird is common. A number of recent reports suggest the decline of turkey and black vultures (*Coragyps atratus*) in certain regions (Wilbur 1983, Tate and Tate 1982, and Brown 1983) with an overall stable national population (Robbins et. al. 1986). Population trends based upon cursory observations (little quantitative data) suggest increases in Montana, decreases in Oregon and California populations, and an stable national population (Robbins et. al. 1986). Significant population increases in the eastern United States are thought to be responsible for increases suggested in Montana. Expanding urbanization along the west coast is thought to be responsible for population decreases observed in Oregon and California.

Local Occurrence

Turkey vultures were commonly observed throughout our study area this past season. The majority of observations are of birds soaring high above the river corridor and over agricultural lands. No nests or roosts sites have been located in the study area. Many of the same areas used by golden eagles may also provide suitable turkey vulture habitat. Turkey vultures were recorded in two sample sections.

Reproductive Biology

We lack specific information on the nesting chronology of turkey vultures for the study area. Jackson (1983) summarized the reproductive success, nesting phenology and nest site selection for turkey vultures from throughout North and South America. Many studies of this species are based upon the observation of a single pair or territory.

Turkey vultures return to southeast Idaho around the end of March. Observations of "dual sitting" by adults during the pre-nesting period of March to mid-April occurs near what may become the eventual nest site (Davis 1979). Egg laying is estimated to occur in mid-April, with an average of 2 eggs per nest. Clutches may range from 1-4 eggs. The incubation period has been documented from 28-42 days. Data supporting the longer incubation period is better substantiated. The prolonged incubation period is thought to be in response to the cold microclimate of caves turkey vultures often use as nesting sites. Renesting, though known to occur with black vultures, is thought to rarely occur with turkey vultures. Hatching may occur on the same day or be delayed over a 2-3 day period. The nestling period, in which young have not yet left the nest, varies considerably in the literature from 56-88 days (Jackson 1983). There is little information on the length of the post-fledging period though it too is expected to be prolonged (Jackson 1983). Based upon the above mentioned nesting chronology, fledging is expected from late July to late August (Brown and Amadon 1968). Coleman and Fraser (1989) estimated a reproductive rate of 0.42 young per nest.

Ecology and Habitat Relationships

The turkey vulture participates in a

number of gregarious behaviors. Turkey vultures communally roost throughout the winter months of September to March. They have been observed in numbers of 250-500 birds per winter roost. Roost trees may be either coniferous or deciduous species, and are of a structure that provides a protective micro-climate against wind and cold temperatures (Thompson et. al. 1990). The location of roosts is related to food availability and ease in soaring.

Around March, turkey vultures disperse and are found singly or in fewer numbers at roosts until September. They are also seen soaring in large groups called "kettles". It has been theorized that these gregarious behaviors have the benefit of communicating food resources (Rabenold 1983, 1987; Sweeney and Fraser 1986). Turkey vultures utilize large home ranges (x= 37,072 ha) throughout their 6 month nesting season (Coleman and Fraser 1989). Turkey vultures show a lot of variability in their habitat use throughout the west, utilizing forested environments for roosts and nesting and open country for foraging habitat, due to increased food observability and increased food availability if in agricultural lands. Turkey vultures may also select areas that have numerous roads, again because of the increased availability of carrion. Turkey vultures scavenge on carrion ranging in size from large domestic animals to small birds and mammals.

Nesting habitat includes arid western plains and mountains, temperate forests and tropical lowlands (Pattee and Wilbur 1989). Nests are located on rock ledges in caves, down trees and buildings. (Davis 1983, Ritter 1983, Coleman and Fraser 1989). These ledges are not necessarily high or large in area. Nest material is not brought in, but a scrape may be made in the ledge substrate. Turkey vultures appear to usually select nest sites that are within a forested environment and that have few roads and no buildings (Coleman and Fraser 1989).

Detection Methods

Turkey vultures do not randomly occur over their large home ranges, but focus their activities around roosts and feeding sites. They also tend to perch and soar near their roosts and perch near nest sites (Coleman and Fraser 1989). Thus observations of soaring and perched birds during the nesting season can narrow the search of roosts and nests. Turkey vulture nests are not easily located for a number of reasons: 1) they do not audibly defend their nests as do most other raptors and 2) to minimize predation of their odiferous nests, vulture nests tend to be obscurely placed on the landscape in a variety of substrates. Pre-field review of topographic maps and aerial photos for arid country with broken topography that create updrafts, cliffs and rock fields near forests in which roosts are often located is the initial step. Field surveys start with an investment of time watching for adults consistently present in an area. Once observed, adults can often be followed to potential nest locations. Otherwise coursing through potential nesting habitat, including surveys of rock outcrops, boulder fields, abandoned buildings and fallen logs, can result in location of active nests (Coleman and Fraser 1989). Assessment of turkey vulture populations in New Mexico have been based upon road transect surveys over several years (Hubbard 1983).

Red-tailed Hawk (*Buteo jamaicensis*)

The red-tailed hawk breeds in Western and Central Alaska, throughout Canada and the United States, and into Central America, and winters in southern Canada and south within its breeding range (Johnsgard 1990). It is currently unknown where Snake River red-tailed hawks winter. In contrast to most other North American raptors, the red-tailed hawk is expanding in numbers and distribution. Audubon Society counts suggest a 33% increase from the 1970s to the 1980s (Anonymous 1986). The current and historical distributions for red-tailed hawks in the western United States are identical (Harlow and Bloom 1987). The redtail is North America's most abundant wintering hawk, and one of the most abundant breeding hawks.

Local Occurrence

Nesting red-tailed hawks are found throughout the Snake River study area. We have found red-tailed hawks nesting within almost every forested habitat within the study area, including dense Douglas fir forest, mixed fir and lodgepole pine, cottonwood riparian forest, and isolated cottonwoods and aspens in cultivated lands. Red-tailed hawks were detected within eight of our sample sections.

Reproductive Biology

Red-tailed hawk incubation lasts from 28-32 days, with fledging normally at 44-46 days after hatching (Luttich et al. 1971). Locally, red-tailed hawks initiate incubation in the first or second week of April, with hatching in early May (Whitfield and Maj 1994). Red-tailed hawk fledging occurs from mid-June to the first of July.

Kirkley and Springer (1980) reported a range in clutch sizes of 2.0 to 2.9 eggs and brood sizes of 1.9 to 2.6 young for 9 studies over a broad geographic range. In Teton Valley, Idaho/Wyoming in 1992 and 1993 (Whitfield and Maj 1994), average clutch size at sampled nests was 2.9 eggs (N = 49) with no annual variation. Average advanced brood size in 1992 was 2.47 advanced young/successful nest (N = 17), and in 1993 was 2.24 advanced young/successful nest (N = 25).

Ecology and Habitat Relationships

The red-tailed hawk has an extremely wide tolerance for habitat variation, in part due to a broad spectrum of prey species (Johnsgard 1990). Red-tailed hawks are diverse in nest site selection; they will nest in conifers and hardwoods or cliffs or other elevated sites where trees are lacking (Smith and Murphy 1973). In nesting habitat and prey selection, red-tailed hawks are notably similar to great-horned owls, which often use red-tailed hawk nests.

In summer, red-tailed hawks are typically found in upland hardwood forests (aspen and cottonwoods in our area), and grass dominated cover types. Most of the hunting is in short grass areas (Peterson 1979). Nests are typically at the edge of dense stands or within open canopy forests in tall trees, not in the interior of dense forest (Gates 1972). Howell et al. (1978) noted that breeding areas with high proportions of fallow pasture relative to crop pasture had greater productivity. In Teton Valley (Whitfield and Maj 1994), dryland pasture dominated territories were significantly more productive than territories dominated by wetlands, probably because of high ground squirrel populations in the dryland areas.

Detection Methods

Surveys for red-tailed hawk nests are best initiated prior to leaf-out in deciduous forests. Any medium size (2-3' diameter) stick nests located in the tree canopies should be noted and later surveyed from the ground for occupancy from late March to mid-May when incubating birds can be observed. Adults are quite vocal during their nesting period and this behavior alone may direct attention to specific nesting areas. Young birds are also vocal. Their food-begging vocalizations from mid-June to early August will focus attention to potential nest sites. All ground surveys should be conducted in a manner that will minimize disturbance to nesting birds so as to avoid the potential of territory abandonment. Surveyors should remain alert and use spotting scopes to view nests from a distance when possible.

Swainson's Hawk (*Buteo swainsoni*)

Swainson's hawks breed locally in east-central Alaska, western Canada, and the western United States east of the coast ranges (Johnsgard 1990). The Swainson's hawk has declined significantly throughout much of it's range including California (Bloom 1980), Nevada (Herron and Lucas 1978), Southeast Oregon (Littlefield et al. 1984), and Saskatchewan (Herron and Bechard

1983). Although historically documented as one of the most abundant buteos in the west, red-tailed hawks now outnumber Swainson's hawks throughout their range. These declines are mostly due to loss of habitat, losses of bottomland forested areas and shelterbelts, and also to pesticide use on winter ranges. There is also some concern that red-tailed hawks are replacing Swainson's hawks because of habitat change. In California, Swainson's hawks are listed as threatened, and in four other states as species of special concern. The Swainson's hawk is listed as a BLM sensitive species. Swainson's hawks are neotropical migrants: Swainson's migrate to the pampas of Argentina for the winter, although a few rarely winter in the extreme southern U. S.. It also appears to have a lower breeding potential than its more successful cousin, the red-tailed hawk. Although common in Idaho, it has declined in much of its former range. For these reasons, we regard the Swainson's hawk as a species worthy of close monitoring in this area.

Local Occurrence

We have found Swainson's hawks nesting in aspen stands on upland portions of the study area and along the mainstem Snake River at the edge of cultivated fields and pasture lands in the lower end of the area. We commonly see foraging Swainson's hawks over hayfields and meadows and at the edge of the foothills in Swan Valley, and over farmlands at the edge of the Snake River corridor at lower elevations. We saw Swainson's hawks at two sample sections. Although frequently seen, Swainson's hawks are far less common locally than are red-tailed hawks.

Reproductive Biology

Swainson's hawks arrive in the study area in late April and begin to nest in early May (Whitfield and Maj 1994). Egg-laying occurs in mid-May, with hatch dates in mid-June. Fledging occurs in late July-early August. Incubation in the Swainson's hawk lasts for about 34 days. Fledglings leave the nest after 38-46 days, and may remain largely dependent upon the adults for food until near migration (Fitzner 1978). Swainson's hawks migrate south from the study area by early October.

Clutch sizes are usually 1-3 (Dunkle 1977, Fitzner 1978). In nearby Teton Valley (Whitfield and Maj in prep), average clutch size for 1992-1994 was 2.13 eggs/active nest (N = 15), and average advanced brood size of 1.78 young/brood (n = 13).

Ecology and Habitat Relationships

Swainson's hawks return to old nests, and also use old magpie nests, or old crow or raven nests (Fitzner 1978). Nesting areas are usually in broken grasslands and cultivated areas with scattered trees (Dunkle 1977). Woodbridge (1987) reported that Swainson's hawks in California strongly preferred irrigated alfalfa fields over drier rangelands, probably because of the greater prey base. Bechard (1982) found that cultivated fields were not highly used for foraging until after crop harvest had reduced plant cover. He suggested that vegetative cover may have been more important in foraging habitat selection than relative prey density. In Teton Valley (Whitfield and Maj 1994), Swainson' s hawk nests are in valley uplands near the valley edge. These areas feature scattered aspen stands, pasture lands and cultivated fields. Hayfields are highly used for foraging throughout the summer, most notably early in the irrigation season and after cutting when vegetative canopy cover is relatively low. Schlorff (1985) noted that Swainson hawk population declines in California are in part due to loss of nesting trees from agricultural development.

Detection Methods

Swainson's hawk nest surveys follow the same protocol as that for red-tailed hawks: detection of nests prior to leaf-out and follow-up ground surveys to determine species occupancy. It is important to keep in mind that Swainson's hawks nest later than most local raptors (Ap-

pendix A, Table 1). Detection of medium size sticknests in trees (often in a single tree or narrow stringer of trees) is preferably initiated prior to leaf-out. We have, however, noted that Swainson's hawks often build new nests after leaf-out. Swainson's nests are also smaller and less conspicuous than red-tailed hawk nests, in part because they are often built low in the canopies of relatively small trees.

Medium size stick nests, vocalizations, defensive adults and food-begging juveniles are all important clues to focus nest searches. Ground surveys for territorial adults can be initiated in early May and continue until mid-August in southeastern Idaho. This window of time includes that period when juveniles are still in the nest or within close proximity and vocally food-begging.

Ferruginous Hawk (*Buteo regalis*)

This raptor is distinctively a species of the Great Plains of North America (Johnsgard 1990). The ferruginous hawk breeds from the grasslands of Canada south to Oregon, Nevada, Arizona and Oklahoma. Populations within the intermountain west utilize large expanses of grassland habitat often associated with broad valley bottoms. Because of this dependence upon large undisturbed grasslands, the rarest habitat in North America, the Ferruginous hawk is in serious decline in many areas (Houston and Bechard 1984, Schmutz 1984, Woffinden and Murphy 1985, USDI 1992) The total ferruginous hawk population in North America has been recently estimated at 3-4,000 (Woffinden and Murphy 1989). The Idaho population has been estimated at 200-250 pairs in 1979 to a minimum population of 100 breeding pairs (USDI 1992). Wyoming probably has as good a population of this species as any state, with over 800 pairs (Oakleaf 1986). The ferruginous hawk is listed as a Category 2 candidate species throughout its range. It is a BLM sensitive species. The ferruginous hawk is a Priority 3 species in Wyoming, and a sensitive species in regions 1, 2, 3, and 4 of the Forest Service. This species has been considered, but thus far denied, for federal listing under the Endangered Species Act (USDI 1992). The ferruginous hawk is considered threatened in Canada.

Local Occurrence

Ferruginous hawks were not detected this past field season in the study area. Potential nesting habitat exists in the lower end of our study area and on some of the grass/sagebenches above the Snake River Canyon. In general, our study area offers marginal habitat compared to more suitable habitat in our region.

Reproductive Biology

Ferruginous hawks will use natural and man-made structures for nesting platforms (Gaines 1985). A variety of nests sites and substrates are used by ferruginous hawk including power poles, artificial nest platforms, trees, willow and ground nests (Thurow and White 1983, Schmutz 1984, Gaines 1985, Bechard et. al. 1990, Restani 1991). More so than other large buteos, the ferruginous is thought to have relatively high reproductive potential. Adult courtship occurs in mid-March, with initiation of nesting in April. Clutches vary from 2-4 eggs per nest and has been correlated with both nest substrate (ground vs tree) and prey abundance (Lokemoen and Duebbert 1976, Woffinden and Murphy 1977, Smith et. al. 1981). Incubation lasts 32 days with both adults participating.

Young ferruginous hawks fledge between mid-June and late July, at about 30-50 days post hatching. Number of young fledged per nest ranged from .67 to 2.67 (Fitzner et. al. 1977). Based upon adult (25%) and first year (60%) mortality rates, 1.5 young fledged per nest is necessary for population stability (Wollfiden and Murphy 1989). Juvenile birds will stay in the nesting territory anywhere from 10-40 days (Konrad and Giler 1986).

Ecology and Habitat Relationships

The ferruginous hawk is typically a resi-

dent of open grassland habitat. Local areas may be used during migration and the post-breeding season as northern birds migrate south. Nesting is well documented in Dubois, Kilgore and Roberts Idaho. A number of studies describe the variable responsible for the separation and co-existence red-tailed, Swainson's and ferruginous hawks relative to their habitat, nests structures and prey (Thurow and White 1983, Bechard et. al. 1990). Restani 1991, found the greatest nesting chronology and prey overlap between red-tailed hawks and ferruginous hawk which had the least nesting habitat overlap. The reverse was true between Swainson's hawk and ferruginous. In general this species avoids areas where large tree stands and agriculture (plowed lands) dominate the terrain. They are closely associated with shrub-steppe and grassland communities. Their main prey base is made up of small mammals and birds including; jackrabbits, pocket gophers, desert cottontails, ground squirrels, western meadowlark, black-billed magpie and snakes (Fitzner et. al. 1977, Thurow and White 1983, Olendorff and Fish 1985, Restani 1991). Local impacts may occur if a nest site is repeatedly subjected to human disturbance. At the larger scale, habitat loss through the conversion of grassland to monotypic crop lands has significantly impacted this species (Gilmer and Stewart 1983, Schmutz 1984).

Detection Methods

Ferruginous hawk build large stick nests (>2.5 feet in diameter) on raised surfaces such as rock outcrops and cliffs, in a single juniper, man-made structure or on the ground. Such nests are quite conspicuous, particularly when viewed in the open habitat where ferruginous hawks typically reside. Nests are easily detected by ground surveys (driving or walking). Adult ferruginous hawks display territorial behaviors within .5 miles of their nests. Surveys should be initiated in March at courtship and continue into mid-April, the nesting period in southeastern Idaho. It is during this time that the large, light-plumaged juveniles are conspicuous on nests. Ferruginous hawks are sensitive to human disturbance and should thus be avoided prior to hatching.

Northern Harrier (*Circus cyaneus*)

The northern harrier is a resident of the western United States, Canada and Alaska (Johnsgard 1990). Northern populations of the harrier generally migrate southward to the lower tier States, some birds migrating as far south as Mexico and Central America. The extent of migration from nesting habitat is dependent upon availability of prey and severity of weather conditions (Craighead and Craighead 1956). The single harrier species residing in North America is thought to be common within limits of it's normal range and suitable habitat (Martin 1987). Johnsgard (1990), however, described the southern breeding range of the species as retracting and the overall population in decline. The northern harrier has been on the Audubon Society's Blue list of potentially declining species from 1972 through 1986 (Johnsgard 1990). Habitat loss and degradation are the suspected causes of population depressions.

Local Occurrence

Though a common diurnal raptor of southeastern Idaho, harriers were detected in only 1 of our sample plots on the western end of the study area. We observed them frequently in open grass/shrub communities adjacent to our sample areas. Our observations suggest that harriers are common in the general area, but most often in sage/grassland habitats and seeded grasslands outside our sample area.

Reproductive Biology

Courtship starts in early April with dramatic aerial flights and ground nest building, which is primarily completed by the male. Egg laying is in early May. A clutch of 4-5 eggs is incubated for 30-32 days, and hatched generally by the end of June. Hatching can be extended for

1-10 days due to the long interval between egg laying and the variable onset of incubation. The female may simultaneously attend a young brood and still be incubating the remaining clutch of unhatched eggs. A ground nester, harriers are highly susceptible to terrestrial predators. The number of successfully fledged young can vary considerably, ranging from 1.6 to 2.4 young on average. The adult male may abandon the nest area prior to fledging of young as the adult female increases her hunting effort.

Ecology and Habitat Relationships

The harrier is a species of open county. This diurnal raptor is specifically associated with mesic grasslands and wetland habitats for nesting. Harriers forage in a diversity of habitats, but use mesic sites and cultivated areas disproportionate to their occurrence. Martin (1987) found harriers a considerable distance from wetlands in dry shrub steppe habitats in southwestern Idaho. The northern harrier has been described as a "hawk that is ruled by a mouse", indicating it's close tie to voles (Hamerstrom 1986). This raptor does show an ability to diversify its prey base, to include cottontail rabbits, ground squirrels and small passerine birds, dependent upon seasonal availability. The northern harrier is similar to the short-eared owl in it's hunting adaptations (facial disk) and strategies (reliance on auditory cues) in locating prey (Rice 1982).. There have been a number of studies illustrating the prey and habitat overlap between these two species (Weller et. al. 1955, Clark 1972). The home range of adult harriers has been estimated at 2.41-14.0 sq km. (Martin 1987). The mesic, grassland habitats selected by the harrier reduces competition with other local diurnal hawks.

Detection Methods

Ground surveys are the most reliable method for detection of northern harrier ground nests, which are commonly located in densely vegetated, wet areas. Rather than randomly surveying a large area, nests can be located by observing paired adults during the nesting period to focus ground survey efforts. Adult courtship flights, prey deliveries and later in the season, fledged young, can indicate areas of nesting activity. Locations where these observations are made should be systematically searched.

Northern Goshawk (*Accipiter gentilis*)

The northern goshawk is holarctic in distribution. In North America, it is found in the northern forests of California, Washington, Oregon, and the Northern Rockies across to the northeastern states and south into the western montane zone of California, Arizona, New Mexico and Nevada. It is an interior forest species associated with both deciduous and coniferous forests. Research performed in the Southwest, Pacific Northwest and Intermountain areas indicate goshawk population declines. Breeding bird surveys suggest a significant downward trend in the United States population, although the western population is listed as stable (1980-1989). The northern goshawk is listed as a category 2 candidate for listing as a threatened or endangered species. The northern goshawk is recognized as a sensitive species in Forest Service Regions 2, 3, and 4, which includes southeast Idaho.

Local Occurrence

Nesting goshawks have been found in conifer, cottonwood, aspen and coniferous forests along the South Fork of the Snake River. An interior forest raptor, goshawks are not easily detected nor commonly observed. Population trend is unknown since the historic occurrence and density of the goshawk is undocumented for the study area. There are a diversity of suitable nesting habitats. Goshawks are also known to congregate in low elevation stands of deciduous trees and shrub in the winter (pers. observation M. Maj). It is speculated that these birds may represent goshawks that nest at higher elevations in surrounding coniferous forests. The moderate winter temperatures and deciduous

habitat along the river corridor provide suitable winter habitat. We saw a goshawk in one sample section in 1994, and are aware of several nests within the study area.

Reproductive Biology

Northern goshawk can be observed in courtship flight above nests stands by mid to late March. Courtship flights and nest building occur during this time for about 1 month prior to egg-laying. Clutches range from 2-4 eggs and are laid at 1-2 day intervals. Incubation lasts from 30-32 days and is primarily performed by the female. Hatching, based on back-dating from observations of recently hatched birds, is estimated to occur during the first part of June. Juvenile females will leave the nest at approximately 40 days of age and the smaller males at 35 days of age. During the fledging-dependency period, juvenile birds are highly vocal and their food-begging calls can be used to detect nest sites. This occurs from early July to mid-August, with the average date of fledging around the middle of July. The number of young fledged from successful nesting attempts is 1.7-2.5 young/nest (Reynolds and Wright 1978).

Ecology and Habitat Relationships

In the western United States, the northern goshawk has been associated with mature and old growth forest which can look markedly different depending upon the specific zone (i.e. Pacific vs northern Rockies) (Reynolds et al. 1982, 1989, 1992; Hayward and Escano 1989, Crocker-Bedford 1990, Patla 1991, DeStefano and Meslow 1994). Others consider the goshawk a generalist, utilizing all major forest types and a variety of age and successional stages (Reynolds et. al. 1992) High vegetative diversity for foraging may also be an important component of goshawk habitat (Hargis 1991). Based upon their location, these stands may have single or multiple layered canopies and are typically less dense than those used by sharp-shinned or Cooper's hawks (Reynolds 1983, Reynolds et al. 1982). The majority of nests found on the Targhee National Forest are associated with mature Douglas-fir forests, although nests have also been found in aspen and lodgepole pine stands (Patla 1991). The northern goshawk preys on mammals the size of tree and ground squirrels, hares and a number of avian species including sapsuckers, woodpeckers and mountain grouse. The current decline of this species is mostly associated with the loss of nesting habitat, foraging habitat and prey and their habitat associated with certain timbering and livestock practices, and fire suppression (Herron et al. 1985, Bloom et al. 1986, Crocker-Bedford 1990, Reynolds et al. 1992)). Human disturbance, poaching, and pesticides may also affect goshawks in some areas.

Detection Methods

All three accipiters nest within forested environments, each preferring a diversity of stand characteristics that range from young, dense, closed canopy stands to late succession, moderately open stands. A number of researchers have implemented the use of conspecific vocalizations to increase the detection of accipiters (Kennedy et al. 1993, Mosher et al. 1990, Rosenfield et al. 1988, Kimmel et al. 1990). Three vocalizations have been used for accipiter detection—the wail, alarm and food-begging calls (Kennedy et al. 1993). Broadcast calls of other raptors (great horned owls) have been used to elicit goshawk responses and increase species detection often with less effectiveness (Kimmel et al. 1990).

With experienced surveyors, Kennedy et al. (1993) found the highest detection of goshawks with the use of the alarm call during the nestling period and the wail or food-begging call used during the fledgling-dependency period. Rosenfield et al. (1988) had greater success eliciting Cooper's hawk responses using broadcast calls during the nestling period. Joy et al. found goshawks responding to taped vocalization ("alarm and food-begging") more often during nestling than fledgling period. The highest probability of detecting a goshawk within 100 m of a nest using taped vocalizations occurred

during the nesting period (70%) Kennedy et al. 1993. Beyond 300 m from a nest, the probability of detecting a goshawk without the use of taped vocalizations was zero (Kennedy et al. 1993)

Taped vocalization surveys should be conducted between June (nestling period) and August (fledgling-dependency period) for goshawks. Repeated visits and surveying for goshawks during their nest building and incubation periods (prior to May 15) should be avoided in order to minimize the potential of nest site abandonment (USDA 1993). Goshawk detection using conspecific broadcast calls was most successful when conducted between sunrise and noon (USDA 1993). Goshawk vocalizations can be easily confused with Cooper's hawk, and jays which mimic goshawk calls. Adult female vocalizations are lower and louder than are adult males which have lower and louder vocalizations than juvenile goshawks. Adult females have been found to be more respondent to broadcast calls than males (Fuller et al. 1981, Kennedy et al. 1993). Ground surveys can be initiated in March when adults are flying above nests stands in courtship flights.

Cooper's Hawk (Accipiter cooperii)

A species of temperate North America the Cooper's hawk is considered common in most states it ranges in (Reynolds 1989). However, few-state wide population estimates are available. It can be a migratory species in some areas, wintering Mexico and Central America. It can be found breeding from Canada to Mexico. The Cooper's hawk, as with many other raptors, has experienced significant declines throughout North America associated with the persistence of DDT in the environment. The Cooper's hawk has been recognized as a species of special concern since 1971. Although Cooper's hawk reproduction has been improving in the eastern United States, improvements have not been documented in the western United States where pesticides are thought to be affecting local populations.

Local Occurrence

A number of Cooper's hawks have been observed in the study are this past season. One adult was observed feeding on a prey item along the Heise to Black Canyon road on the north side of the river. This observation was in sage/grass habitat with the closest trees along the river within .5 mile. Another adult Cooper's hawk was observed in a conifer stand adjacent to the river. Numerous accipiter nests were later found in a stand of Douglas-fir near by. Cooper's hawk habitat does exist in the study area and more birds are expected upon further survey. We noted Cooper's hawks in two sample sections.

Reproductive Biology

Cooper's are a little behind goshawks in their arrival to their nesting territories, arriving from late March to early April. Pair formation, nest building and copulation takes 2-4 weeks before egg-laying occurs. Clutches of 3-6 eggs are laid around mid to late May and are incubated for 30-32 days. (Reynolds and Wight 1978) After hatching in late June, juveniles remain in the nest for another 27-30 days, attaining flight on the average sometime in July (Henny et al. 1985, Kennedy and Johnson 1986, Johnsgard 1990, Wiggers and Kritz 1994). Juveniles may remain near the nest dependent upon parental prey deliveries for another 3 weeks. The number of fledged young per nest attempt ranged from 2.0 to 3.6 (Reynolds and Wight 1978, Reynolds 1989).

Ecology and Habitat Relationships

The Cooper's hawk nests within deciduous and mixed forests such as those found along riparian zones, within small woodlots or in semiarid stands (Reynolds 1989). More so than other accipiters, Cooper's hawks will utilize open, small forested stands and second growth forests (Beebe 1974, Reynolds and Wight 1982, Moore and Henny 1983). When found in large continuous forests, they often nest near the edge of the stand. However, within these stands Cooper's

tend to place nests within the tree crown canopy or on mistletoe growths. Both strategies are thought to provide more cover and security from predators (Moore and Henny 1983). The Cooper's hawk is considered more of a generalist in its foraging than the sharp-shinned hawk. It will take both birds and mammals ranging in size from 44.2 g to 296.4 g, respectively (Storer 1966, Reynolds and Meslow 1984). It will take tree squirrels, chipmunks, ground squirrels, Stellar's jay, juncos, northern flicker, quail and robins to name a few prey (Kennedy and Johnson 1986, Reynolds 1989). The Cooper's home range is also quite variable, having been documented to range from 173 ha to over 1,500 ha (Craighead and Craighead 1956, Reynolds 1983). This species' large home range results in relatively low density over a larger landscape. The long-term conservation of this species will depend upon preserving quality nesting habitat and reducing pesticide contamination.

Detection Methods

The same survey protocol described for goshawks applies, with consideration to specific habitats used by Cooper's hawks (Rosenfield et al. 1988). Rosenfield (1985) noted that timing of taped calling is vital; Cooper's hawk adults did not respond during incubation. Tapes were an advantage to nest surveyors after hatching. Methodical ground surveys of areas at which adults were observed or vocalizing birds had earlier been identified have resulted in successful location of Cooper's hawks (Bosakowski et al. 1993).

The following unique features can help differentiate accipiter nests from other raptor nests: medium size nest against the bole of the tree within the canopy of the tree, nest may be lined with fresh green material such as conifer or deciduous tree limbs. Buteos, the raptors most likely confused with accipiters, may also line their nest with fresh tree limbs. It may take a combination of these unique habitat and nest features to differentiate between accipiter and buteo nests. Note Appendix A, Table 2 for specific information on breeding chronology.

Sharp-shinned hawk (Accipiter striatus)

The heart of the sharp-shinned hawks breeding range in North America is found within the boreal forests of Alaska and Canada. Other populations are found within California, the Northern Rockies, Arizona, New Mexico, Great Lake states, northern parts of Gulf states and the eastern states (Johnsgard 1990). The most migratory of the 3 accipiters, individual birds may winter as far south as Mexico to South America. Sharp-shinned hawk populations underwent a significant decline in the 1950s-1970s due to DDT contamination. Although there have been notable population increases recently, DDT is still found on it's South American winter range. The sharp-shinned hawk is considered a fairly common species in the western states (Reynolds 1989). The sharp-shinned hawk does not have any special state nor Federal status.

Local Occurrence

Sharp-shinned hawks have been observed a number of times and places in the study area. All of our observations have been made in higher elevations off the river bottom, generally near dense Douglas-fir stands. A preference for north facing conifer stands thought to represent more mesic habitat has been documented in other studies (Hennessy 1978, Reynolds 1978).

Reproductive Biology

Concealment from predatory raptors is important to this small accipiter. Sharp-shinned hawks achieve concealment by nesting in the thick foliage of conifers and some mixed deciduous forests (Reynolds et al. 1982, Moore and Henny 1983, Reynolds 1989). Sharp-shinned hawks arrive on nesting territories during early May. Egg-laying is finished from the end of May to mid-June. Clutches range in size from 2-6 eggs and are hatched about 30-32 days later in mid- to late-July (Reynolds and Wight 1978, Johnsgard 1990, Quinn 1991). Hatching of all eggs seems to

occur within a 1-2 day span (Reynolds and Wight 1978). Juveniles attain flight at approximately 21-24 days of age, but may remain in the nest territory for another 3 weeks to be fed by attendant adults. The range of fledged young per nest attempt is 2.7-3.5 (Reynolds 1989).

Ecology and Habitat Relationships

Of the three North American accipiters, the sharp-shinned hawk uses the youngest, most dense forests stands. It is thought that 80% of the North American breeding population nests in the boreal forest of the continent. The combination of a conifer patch within a larger deciduous stand is thought to provide preferred nesting habitat (Platt 1976, Reynolds 1989 Joy et. al 1994). Conifer stands are identified as important in providing a diversity of passerine bird species which are the primary prey of this highly specialized, bird-catching predator. Birds comprise the main prey item though small mammals such as voles, pocket gophers and shrews may also be taken. Their main diet includes many small birds, such as yellow-rumped warblers, robins, sparrows and juncos (Joy et al. 1994) Prey size averages at 17.6 g for males and 28.4 g for females. Foraging occurs in a variety of habitats, including shrub communities, deciduous and conifer forests and open habitats adjacent to nesting habitat. In the western United States, sharp-shinned hawks may move downslope, wintering in open woodland and foraging in adjacent grasslands (Johnsgard 1990).

Detection Methods

The same survey protocol described for goshawks applies with special consideration to sharp-shinned hawk habitat and nesting chronology (Appendix A, Table 2).

Peregrine Falcon (*Falco peregrinus*)

The Peregrine falcon, "the wanderer", breeds on all continents but Antarctica. In North America, the peregrine is found from the far north to Baja California and coast to coast (Johnsgard 1990). By the mid-1960s, fewer than 20 active peregrine eyries were known in the Rocky Mountain states, and none in the Greater Yellowstone Ecosystem (Platt and Enderson 1989).

The current distribution of the peregrine falcon in North America exists due to the successful reintroduction of this falcon through hacking and captive breeding. The peregrine falcon is listed as an endangered species by the Fish and Wildlife Service and on state lists. The current western population is now over 300 pairs (Peregrine Falcon Foundation 1993). The Greater Yellowstone Ecosystem is noted as an area of both historical peregrine falcon breeding and recent recovery due to reintroduction efforts (Platt and Enderson 1989). Threats to this species include contamination from pesticides, particularly in southern wintering areas, repeated human disturbance at nest sites and loss of prey base.

Local Occurrence

Outside the breeding season, peregrines are occasionally seen throughout the study area. Peregrine falcons nest at two locations within the study area. Nest sites are on cliff faces, one within a large cliff complex in the canyon section, and another on a small cliff near the river. No peregrines were seen in the randomly selected sample sections.

Reproductive Biology

Peregrines return to nesting eyries in April; breeding behavior is initiated later than by prairie falcons. In a period of pre-nesting courtship, paired adults exhibit their considerable flight abilities through well-studied aerial courtship displays (Cade 1982). Intruders are vigorously displaced from the nesting area. Pairs tend to reoccupy the same eyrie year after year, and pair bonds are thought to be retained for long periods.

Clutch sizes average about 3 eggs/eyrie (Bull 1974). Incubation takes 32-34 days from laying of the last egg to the nearly synchro-

nous hatching (Porter et al. 1973). Both sexes participate in incubation. Fledging occurs after 35-42 days.

Ecology and Habitat Relationships

The primary feature of peregrine falcon nesting habitat is usually a tall nesting cliff. Cliffs occupied by peregrines are typically over 150 feet high with an unobstructed view of surrounding foraging habitat and with ledges large enough to serve as nest and perch sites (Cade 1982, Johnsgard 1990). Nesting habitat may be most restricted by access to prey species, most often shore birds and waterfowl, or pigeons. Foraging occurs in a wide variety of habitats, including riparian woodlands, forest lands, shrublands, and prairies. Prey taken is mostly small birds, including swallows, shorebirds and mourning doves in riparian areas and passerines the size of gray jays and nutcrackers over high elevation forests (Sherrod 1978). We have seen local peregrines take rock doves from near the river canyon walls on several occasions. Peregrines also take some small mammals and insects.

Detection Methods

Surveys for eyries start with the delineation of suitable nesting habitat. Where large areas of suitable habitat exist aerial surveys can expedite the search. In our area the rare observation of an adult can narrow the search for the eyrie to a specific cliff or river stretch. Ground surveys are primarily just extended observation time behind a spotting scope at a cliff wall. The best time to survey rock walls for falcons flying in or out of eyries is best conducted early in the morning (1-4 hours post sunrise) and later afternoon (1-4 hours pre-sunset). Nest scrapes are often difficult if not impossible to observe from the ground and is again best delineated by the presence of an adult flying in or out of a crevice. Narrow, vertically streaked white-wash excrement on a rock wall is a distinct sign of the peregrine or prairie falcon (buteos and eagles white-wash is described more as a broad splash) and such observation is an indication of falcon presence. A "kacking" vocalization can also indicate the presence of a falcon. Surveys for territorial birds should be initiated in mid-March in suitable habitat. Juvenile peregrines are fledging around late June to late July.

Prairie Falcon (*Falco mexicanus*)

The prairie falcon breeds in the western North America east of the Pacific coastal ranges from British Columbia to Baja, across the Great Basin, Rocky Mountains and grasslands of the Dakotas, Colorado and western Canada. Prairie falcons winter a bit farther east and south across Texas and into Mexico (Johnsgard 1990). In winter, prairie falcons sometimes move to lower elevational open country within the breeding range where horned larks or other small birds or mammals are available as prey. This species is on the Audubon list of declining species, but may be secure on a continental basis (Cade 1982), with a total estimate for the species of 5 to 6 thousand pairs.

Local Occurrence

We are aware of three prairie falcon eyries within the study area, 2 in small cliffs on the canyon rim and 1 on a big wall in the South Fork canyon section. In 1994, we detected flying prairie falcons at one sample quadrat outside of these known nest areas.

Reproductive Biology

Prairie falcons return to eyries in March to April, and begin a courtship that may last for a month. Clutch sizes average about 4 to 5 eggs (Cade 1982). Egg laying occurs at an interval of about 2 days, or about 10 days for the entire clutch. Incubation, which takes 29-33 days, is not initiated until all the eggs are laid. The female does most of the incubation, although the male performs this task while the female eats the food that he brings into the scrape. Numbers of young

in advanced-age broods is highly variable (Kockert et al. 1983). Young falcons hatch close together, and fledge after about 40 days. There is high mortality of young falcons, 74% in one study (Shor 1975).

Ecology and Habitat Relationships

Prairie falcons select nesting eyries in cliffs or escarpments. The landscapes surrounding their nests sites are often semi-arid open lands, sagebrush basins or grasslands (Marti and Braun 1975). Nests are usually in rock cavities in sheer cliffs with overhanging ledges and a broad vista. Most nests are within pothole-like cavities in cliffs about 30 m high (Runde and Anderson 1986). Prairie falcons also nest in rock crevices and old stick nests used by other species. Home ranges of 26 to 141 km squared have been noted (Craighead and Craighead 1956). Birds and mammals make up the majority of their food base in varying proportions (Peterson et al. 1977, Boyce 1985, Squires et al. 1989). Prairie falcons suffer from many local problems, including pesticides, grassland conversions, and disturbance of nesting areas.

Detection Methods

The same survey protocol described for the peregrine falcon applies to the prairie falcon. These species can share similar habitat and nesting chronology in our area, although prairie falcons may arrive in nesting cliffs earlier (Appendix A, Table 2). The vocalization "jiink, jiink, jiink" made by an adult prairie is indicative of the presence of young falcons.

Merlin (*Falco columbarius*)

Merlins are found in the north of North America and Eurasia (Johnsgard 1990). Merlins nest in northwestern Alaska, throughout Canada, and into the northern prairie states: Montana, the Dakotas, Wyoming, and western Nebraska. The southernmost extension of the merlin's North American range is into central Wyoming and eastern Idaho (Craig and Craig 1989). No verified merlin nests have been reported within the Greater Yellowstone region in recent years, although merlins are occasionally seen within the area during the breeding season (Craig and Craig 1989). Surveys for nesting merlins are needed within the Greater Yellowstone Ecosystem.

Merlins are listed as species of special concern in Idaho and Montana, a priority 2 species in Wyoming, and as a sensitive species by the Bureau of Land Management. Population declines have been attributed to eggshell thinning due to pesticides and conversion of grassland/shrub habitats to cropland (Fox 1971, Becker 1984).

Local Occurrence

M. Whitfield has seen merlins within the study area on two occasions during the breeding season. Both sightings were of adults in sage-dominated habitats. We did not detect any merlins in 1994.

Reproductive Biology

Males typically arrive in breeding areas before females (Becker 1984). New pair bonds are formed each year. Courtship features as many as 14 displays and 4 primary vocalizations (Feldsine and Oliphant 1985). Merlins typically occupy breeding territories in April, and lay eggs in May (Becker 1984, Craig and Craig 1989). Although they usually nest in stick nests of other species, merlins also can nest in tree cavities or cliff scrapes. Black-billed magpie nests with mud cups and stick canopies are often the nest site of choice (Sieg and Becker 1990). They may decorate nests with greenery.

Clutch sizes average about 4 eggs (Becker 1984). The female does most of the incubation, except when the male brings in food. Incubation lasts 28-32 days (26 days/egg). The female helps with hunting after only one week of brooding. Nestlings develop rapidly, and may fly at 26 to 33 days after hatching (Becker 1984). The young start to catch prey (insects) after only 2 weeks of

flight, and are independent of adults after 5 weeks of flight.

Merlins typically have low population densities, and forage up to 9 km from a nest site. Home range sizes have been suggested to range from 13 to 28 square km (Becker 1984).

Ecology and Habitat Relationships

Areas of mixed grasslands and deciduous trees, often quaking aspen, are favored breeding areas (Hodson 1976 from Sieg and Becker 1990). Nesting habitat in southeastern Montana included dry ponderosa pine types (Becker 1984). Most merlin nests documented in Montana have been constructed by black-billed magpies (Sieg and Becker 1990). Such nests can be found in coniferous or deciduous stands. Although Watson (1979) found merlins nesting in conifer forest in Great Britain, the adults were still foraging over open grassland habitats. The type of tree used is thought to be related primarily to the presence of a suitable nest (Sieg and Becker 1990), with no preference for tree species.

Preferred hunting habitat is a patchy mix of sagebrush and open grassland (Becker and Sieg 1987). In their feeding, merlins are strongly bird adapted, but also take a few small rodents and bats (Hodson 1978, Becker 1984). Birds are 75 to 100% of prey and mammals less than 7%. They also eat a few insects. Prey are typically small to medium sized passerines, such as horned larks, sparrows, and thrushes. Merlins are daytime hunters, mostly in early morning and late afternoon to dark.

Methods of Detection

Merlins are rare within our study area and therefore specific nesting habitat and nesting chronology is lacking. Surveys efforts can be narrowed by the presence of defensive, adults vocalizing during the nesting period of mid-April (courtship) to mid-May (egg-laying) (Becker 1977).

American Kestrel (*Falco sparverius*)

The American kestrel is the most common and widely distributed hawk in North America, with an estimated 1.2 million pairs (Johnsgard 1990). Approximately 1/4 of these pairs are thought to winter in North America. Idaho is among those states with the greatest numbers of kestrels in the west, with a reportedly stable kestrel population (Platt and Enderson 1989). Aside from the southeastern population which is "threatened" in Florida, the American kestrel does not carry any special Federal or State status.

Local Occurrence

Kestrels are among the most common raptors in the study area and throughout eastern Idaho. We have seen kestrels at all elevations and within or near all habitat types in the study area. Kestrels were seen or heard in seven sample sections.

Reproductive Biology

Kestrels return from wintering grounds to this area in late March to early April. Pairs are very vocal as they complete aerial displays and courtship feeding. Males select and defend territories, and the pair selects a nesting cavity together. Kestrels often displace woodpeckers, and compete with screech owls and other species for suitable cavities (Balgooyen 1976).

Clutch sizes are around 4 eggs (Heintzelmann and Nagy 1968, Balgooyen 1976). Both adults incubate, although the female completes about 80% of this task. Incubation takes about 30 days, with fledging about 30 days later.

Ecology and Habitat Relationships

The American kestrel is a secondary cavity nester; it uses nesting cavities which were excavated by other species. As such, the kestrel is dependent on the northern flicker over much of its distribution (Balgooyen 1976). Kestrels

have an extremely wide ecological tolerance relative to elevation, tree species and type of forested environment. Kestrel distribution is strongly influenced by the availability of adequate nesting cavities and perches. Home ranges may be as small as .68 square km if there sufficient cavity nesting opportunities (Smith and Murphy 1973).

Since over 95% of forages are initiated from a perch, and prey is usually taken at ground level, perches within open areas are important habitat features (Balgooyen 1976). Hunting usually occurs over open terrain, with a preference for open, exposed ground in vegetated areas. Open savanna-like areas and forest edges are preferred.

Two potential threats that could occur locally to this species are the loss of cavity trees and pesticide contamination through ingestion of insects, insect eating birds or small mammals. Highly valued cavity trees are aspen and cottonwood.

Detection Methods

Adult kestrels are highly vocal during the nesting cycle, and although relatively small, are very visible because they are very active. Nests are usually within .25 miles of observed birds during the nesting season. Nest searches are conducted by systematic ground surveys for cavities. Active nesting cavities can best be detected by visually tracking adult male prey deliveries and listening for food-begging juveniles prior to fledging. Note Appendix A, Table 2 for nesting chronology.

Great-horned Owl *(Bubo virginianus).*

The great-horned owl is found throughout the Americas in a broad range of habitats (Johnsgard 1988). Great-horned owls are relatively sedentary in that they may remain within breeding territories year around. Migration to more southern areas may occur in years of poor prey availability. Despite continued losses due to shooting and collision with vehicles, this species is successful in much of its range. Local declines have been noted in areas of habitat destruction.

Local Occurrence

The great-horned owl is probably our most common nocturnal raptor. The great-horned owl is a generalist, and lives in a great variety of habitats throughout the study area and the mountains around the area's periphery. The great-horned owl is often found nesting and/or roosting in mature riparian cottonwood forests along major tributaries, but prefers to hunt in open fields and forest edges. We also find the owls in the willow-swamp community and nearby pasture lands, with nests located in aspen stands or isolated cottonwoods. We have heard calling great-horned owls in riparian bottoms all over the study area, and also in conifer-covered foothill areas and in the lower elevations of major mountain canyons. We detected great horned owls in three sample sections.

Reproductive Biology

In other studies, adult pairs begin to roost together in late December after being nearly solitary throughout the fall, courtship begins in January, and egg laying occurs in late February (e.g Petersen 1979). Incubation lasts from 26-35 days, with 30 days probably an average for uninterrupted incubation (Gilkey et al. 1943). The young owlets grow rapidly in the first month, and regularly leave the nest to climb into nearby trees to hide in the branches at 5-6 weeks of age. They may fly short distances at 45 days of age, but are not proficient flyers until 9 or 10 weeks old. The young owls are dependent upon the adults for long periods, and may not disperse from the adult territory until as late as mid-winter (Petersen 1979). Young owls are downy until 3-4 weeks of age (Johnsgard 1988). In 1993 incubation was initiated at Teton Valley great-horned owl nests in late March-early April (Whitfield and Maj 1994).

Clutch sizes for great-horned owls tend to be relatively small, averaging from 2.05 to 2.59 across several geographic regions (Murray 1976).

Houston (1971, 1975) reported that brood sizes were largest and eggs were laid earlier during years when prey were abundant. He also noted that more nonbreeding occurred in years when prey were scarce, and that nests were located in more diverse locations (less remote and sheltered) when prey were abundant.

Ecology and Habitat Relationships

It is hard to characterize the habitat of great-horned owls; this species is a generalist, and lives in a great variety of habitats (Austing and Holt 1966). Basic habitat needs are a nest site, roost site, and hunting area. Nests are usually stick nests built by other birds, such as red-tailed hawks or herons; great-horned owls also use cliff nests, ledges, and caves. Roosts are selected for maximum daytime concealment, conifers are favored. Hunting areas are usually relatively open areas, but woodlands or areas with scattered trees are also used. Generally, nesting territories are in open, mature deciduous forests (cottonwoods or aspen) near water. Breeding territories are estimated from several studies (Johnsgard 1988) at 150-250 acres in size.

Great-horned owls adapt to local conditions and take many kinds of prey. These owls usually take larger prey than other owls, all the way from insects to domestic cats and marmots, geese and herons. They often perch on vantage points such as telephone poles and make short flights to prey. They apparently hunt more by sight than most owls, and often hunt in the evening hours before dark.

Leading causes for great-horned owl mortalities continue to be highway collisions and shooting. Educational efforts that emphasize the value of birds of prey might benefit this species particularly, because their habit of perching on roadside poles makes them susceptible to shooters. Although this species is notably secretive, we have located nesting great-horned owls near farm homes and agricultural areas. Great-horned owls often nest in habitats that are human dominated; but generally in local sites that are secluded and little visited by people. Forested areas near nest structures and roosts should be protected to afford security cover to owls. Active nest sites should be avoided during the nesting season as disturbance can cause nesting failures.

Detection Methods

Ubiquitous as this owl is, great horned owl nests are no less difficult to locate than other owls or raptors in general. Preliminary locations of nests can be triangulated from by the territorial calls of both male and female. Males regularly roost within 100 m of nesting females during incubation (Rohner et. al. 1992). The female will usually respond vocally to the male within the first hours of sunset and sunrise. It is during the first hour after sunset and the first hour before sunrise that triangulation of both vocalizing adults can provide a preliminary location of the nests. A ground or aerial search for the nest follows, looking for the presence of owls by searching for signs such as feathers, pellets, and white- wash. The "triangulation and search' survey technique is recognized as time-intensive and that playing taped vocalizations could increase the efficiency of nest searches. This method however, is thought to be less disturbing to nesting birds than is the use of territorial calls.

Broadcast vocalizations have been effectively used to detect great horned owls (Morrell et al. 1991). The detection of great horned owls using broadcast calls can be improved by conducting the surveys on calm nights in January between midnight and 0600, during a waxing moon. (Morrell et al. 1991). The general application of broadcast conspecific calls in eliciting owl responses is described by Smith and Carpenter 1981, Johnson et al. 1981 and Fuller and Mosher 1981, 1987.

Long-Eared Owl (*Asio otus*)

Long-eared owls range broadly across southern Canada and the northern 2/3 of the United States, generally in woodland and forested habitats (Johnsgard 1988). This species is

also found across Asia and Europe at similar latitudes. Forest cutting, particularly in riparian habitats, have caused declines of this species in America, but the long-eared owl is not listed as a species of concern by any agencies in Idaho or Wyoming.

Local Occurrence

We have seen or heard long-eared owls in habitats that feature mixed conifer (mostly open Douglas-fir) and aspen stands and in dense cottonwood riparian forests. We located two long-eared owl broods after fledging in Douglas-fir stands near the river. We found long-eared owls in two sample sections.

Reproductive Biology

The breeding season for long-eared owls is apparently prolonged by variation in initiation of egg laying from mid-March to late May (Bent 1938). We have heard adult males singing in the study area in mid-April. The incubation period is approximately 25 days, but hatching may be prolonged over several days for a large clutch (Johnsgard 1989). Owlets fledge at about 35 days, and gradually become independent at about 2 months of age. We found 2 broods of food-begging fledglings (3 and 4 in number) near the South Fork Snake River on 7/13 and 7/31/93, which suggests hatching in latter May. Marks (1986) reported a minimum of 3.7 fledged young per successful nest in southwestern Idaho, with clutch sizes expected to be near 5 on average (Murray 1976).

Ecology and Habitat Relationships

During the breeding season, long-eared owls are associated with coniferous, deciduous, or mixed composition forests and forest edges (Johnsgard 1988). Long-eared owls use old corvid nests almost exclusively (Marks 1986). During winter, coniferous woods may be very important as roosting cover (Craighead and Craighead 1956). Large numbers of these owls will sometimes congregate at favored winter roosts (Bent 1938). Roost trees may be used repeatedly over the years.

Long-eared owl populations decline in areas where habitats are lost, particularly favored forest areas and riparian habitats. Habitat around any identified roosts should be protected, since these sites often are of long-term value to the species.

Methods of Detection

The same survey protocol using conspecific territorial calls as described for great-horned owls applies for long-eared owls. Note the preferred habitat and nesting chronology of the long-eared owl (Appendix A, Table 3). Nest searches can be further enhanced by triangulation of calling territorial adults as described for great horned owls. Long-eared owls will nest on platforms formed by mistletoe clumps which can be very common in some coniferous stands, Nests can be very difficult to locate. Both long and short eared owls will roost in semi-colonial groups in the winter. Roosts sites are generally densely vegetated either conifers or deciduous stands as low elevations where temperatures are moderate (pers. comm.. D. Holt). Roosts sites are located from the ground by surveying suitable habitat. Surveys of such areas should occur at twilight when foraging birds may be more detectable.

Short-Eared Owl (*Asio flammeus*)

The short-eared owl is a circumpolar species that resides across Canada and approximately the northern half of the United States, usually in open areas such as meadows and marshes (Johnsgard 1988). Northern populations of this owl are migratory in winter, with movements as far south as Mexico and Central America. The short-eared owl is on the Audubon Society's blue list of declining species but has not been recognized as a species of special concern by federal or state agencies in Idaho or Wyoming.

Local Occurrence

Short-eared owls are relatively common residents of the open, grassland, meadow, and marsh areas in the lower elevations of the study area and west of the river. We have not located any short-eared owls within our sample areas, but suspect that they occur in suitable habitats. We have noted considerable annual variation in our observations of short-eared owls in our ongoing studies in Teton Valley, and suspect that population fluctuations may make this owl hard to find in some years.

Reproductive Biology

Egg laying at this latitude and altitude might be expected from mid-April to mid-June (Bent 1938). Whitfield and Maj (1994) observed a courting pair of short-eared owls in Teton Valley on 4/16/92. Incubation lasts about 26 days. The young develop very rapidly, probably because of their high vulnerability to predation: these owls are ground nesters. The young owls may depart from the nest after only 15 days, and fledge at about 25 days of age (Clark 1975). The young may be dependent upon the adults until about 50 days old.

Ecology and Habitat Relationships

The short-eared owl is primarily associated with open habitats such as hay meadows, pastures, old fields and wetlands (Clark 1975). Winter roosts may be found in conifers with similar characteristics to those used by long-eared owls, and may even be shared with these owls (Clark 1975).

This species is susceptible to the suite of ecological changes that can threaten the success of many ground nesting birds, such as unfavorable habitat alteration by factors such as fire or agricultural clearing and destruction by increased populations of foxes, skunks, ravens and other predators. Specific habitats used by these owls for nesting, foraging, and roosting should be identified and protected where possible.

Detection Methods

As a ground nesting species, the nest survey protocol follows that described for the northern harrier. Because this owl is often observed during the daytime, especially early morning and later evening, observed adults can help focus a follow-up ground search. This owl also roosts in small groups, often with long-eared owls, in cottonwood and deciduous forests in the winter. These sites may be detected by observation of foraging adults as they leave the roost in early evening.

Western Screech Owl (*Otus kennicottii*)

The Western Screech Owl is found from southern coastal Alaska throughout coastal British Columbia and the United States west of the Rocky Mountains to central Mexico, and inland as far as northwestern Wyoming, Colorado, Arizona and western Texas (Johnsgard 1988). These owls are found in a wide range of habitats varying from coastal lowlands and the Sonoran desert to temperate rain forests. The species is generally found in open deciduous forest and areas of scattered trees. In many areas, western screech owls have declined due to the loss of riparian forest habitats, although they may be found within urban city parks. The western screech hybridizes with the eastern screech owl along interspecies boundaries.

Local Occurrence

We have detected screech owls in the cottonwood bottom in the Heise area only to date, but suspect that this species will be found in much of the cottonwood forest within the study area. We did not detect any Western screech owls in 1994.

Reproductive Biology

Mating pairs are monogamous and apparently life long, but these are short-lived birds

(life span of 3-4 years). Western screech owls may attempt to breed as 1 year olds (80%, Van Camp and Henny 1975). The pairs display many calls, including duetting when in courtship. Copulations are of 2 seconds duration. Clutch sizes of 4 to 6 eggs, are expected, although clutch size may be smaller in interior populations. Incubation lasts about 26 days, with fledging at 30-32 days. There is very high fledging mortality, about 70%.

Ecology and Habitat Relationships

The western screech owl is generally associated with deciduous tree stands in open country, especially riparian hardwoods (cottonwood) bottoms. In central Idaho, Hayward (1983) noted a strong preference for cottonwood river bottoms. Nearby open grassland habitats were used for foraging. These small owls nest in cavities, in woodpecker holes or natural cavities. They sometimes use flicker holes in deciduous trees along stream sides. They also roost against the boles of cottonwoods where their gray coloration is an effective disguise. We have found screech owls roosted in conifers within cottonwood forests.

Johnson et al. (1979) reported that western screech owl pairs nesting in riparian forests may be separated by as little as 50 m (164 ft.). Territories may be separated by much greater distances.

Detection Methods

These owls respond very readily to taped calls. We have successfully called western screech owls in Jackson Hole and the South Fork at Heise in mid-March to early April in earlier years. The same broadcast calling method described for large owls applies with special attention to screech owl habitat and nesting chronology (Appendix A, Table 3).

Burrowing Owl (*Athene cunicularia*)

The burrowing owl breeds locally throughout the western United States and extreme southern edge of the western Canadian provinces with the exception of the Pacific coast, and in Mexico, Central America, and South America outside of the Amazon River Basin (Johnsgard 1988). It also resides in Florida and the West Indies. These owls are usually found in open, dry pasture lands, grasslands, or deserts where burrows are available. It is migratory in this region, and winters south in unknown areas. The burrowing owl has declined in much of its range, largely because of the removal of burrow building mammals. It is listed as a sensitive species by the BLM and a priority 2 species in Wyoming, but does not have special status in Idaho.

Local Occurrence

Within the Greater Yellowstone Ecosystem, the burrowing owl is found in isolated colonies in rural areas where open plain habitat predominates (Olenick 1989). Nesting by burrowing owls in the GYE may be sporadic (Olenick 1989). We have not detected any burrowing owls within the study area.

Reproductive Biology

Egg laying may occur over a broad period between April and July (Bent 1938, Stewart 1975). With an incubation period of 30 days, and a minimum fledging period of 40 days, the reproductive cycle likely requires 70-80 days (Landry 1979). Burrowing owls have relatively large broods, with an average of 4.6 juveniles/breeding pair at independence (Wedgewood 1976).

Ecology and Habitat Relationships

Typical burrowing owl habitat is open flat pasture land or grassland that has available burrows (Johnsgard 1988). Nesting areas must also feature perch sites such as fence posts or raised rodent mounds (Grant 1965). Nesting may occur in a localized area that would require a focused habitat protection effort. Artificial nest

burrows have been successfully used to enhance burrowing owl habitat in areas where burrowing mammals have been removed (Olenick 1987).

Detection Methods

Ground surveys are used in detecting burrowing owls. Searches should start in known prairie dog towns, short grass communities and disturbed sites such as cut-banks along road, railroad and airstrip ways. Both territorial adults and juveniles will respond to elicited broadcast calls. Generally observations of burrows for a few hours during their breeding season will provide information on presence. Adults may occasionally be observed perched near nest burrows on low elevation structures such a raised land surface or fence posts.

Great Gray Owl (*Strix nebulosa*)

The North American breeding range of the great gray owl includes central Alaska, most of Canada, the Cascades and Sierra Nevada ranges to California and the Rockies into the Greater Yellowstone Region of Idaho and Wyoming (Johnsgard 1988). Great gray owls nest in a variety of vegetation types from subalpine conifer forests to foothill forests interspersed with open areas, and winter at lower elevations. The great gray owl is a species of special concern in Idaho, and a sensitive species within the Targhee and Bridger-Teton National Forests.

Local Occurrence

The Eastern Idaho/Northwest Wyoming portion of the Greater Yellowstone Ecosystem, including the upper elevations of the study area, features a notably large and productive population of great gray owls (Franklin 1987, 1988). We are aware of great owl breeding areas at the edges of the study area in Douglas-fir dominated habitats above the river between Palisades Dam and Conant Valley and in similar habitats in the foothills of the northern Big Hole mountains. Concentrations of wintering great gray owls have been found in cottonwood bottoms in Teton Valley and the upper Henry's Fork near Chester, Idaho (Franklin 1987). Similar winter habitat features are found in Swan Valley and along the upper South Fork and Henry's Fork within this study area, although we have not seen wintering great gray owls here. We did not detect any great gray owls in our 1994 sample sections.

Reproductive Biology

In late winter, great gray owls are increasingly gregarious, with pair formation from early February to a few weeks prior to egg laying in April or May (Franklin 1988). Territorial male great grays are expected to be calling in this region from late February to April. Only females incubate the eggs; breeding females typically commence incubation in April to early May in this locale (Craighead and Craighead 1956, Franklin 1988). Egg laying may be delayed in years of heavy snow cover (Franklin 1988, Whitfield and Maj 1995). Hatching occurs 30 to 36 days after incubation begins (Mikkola 1981, Franklin 1988). The young owlets leave the nest at 3-4 weeks after hatching (Franklin 1988, Bull et al. 1989a), although they do not begin to fly until about 50-55 days old. The young owlets are agile climbers and climb leaning trees near the nest area. The young are fed by an adult, usually the male, for about 3 months after they fledge.

Mean clutch sizes are 3 to 3.3 in Idaho/Wyoming (Franklin 1988), up to 5 in Oregon (Bull and Henjum 1990), with a potential for as many as 9 eggs (Mikkola 1983, as cited in Johnsgard 1988). Fledging-aged broods of 1 to 5 (mean of 2.2) are the norm in Oregon (Bull and Henjum 1990). In a 1994 study in the eastern portion of Targhee National Forest, an average of 2.3 fledged young/brood (n = 10) were found (Whitfield et al. 1995).

Ecology and Habitat Relationships

Great gray owls nest in a variety of vegetation types along their range from north to south. Locally, Franklin (1987) reported that

over 90% of observations of great gray owls in the Southeastern Idaho/Western Wyoming area were in the lodgepole pine/Douglas fir/aspen zone. Most of the nests reported by Franklin were in Douglas-fir forests. The most common nest trees in this region are Douglas fir and lodgepole pine. Aspen are occasionally used. Great gray owls do not build nests; nest structures are usually old hawk (usually goshawk) or raven stick nests, depressions in the tops of broken-topped snags, or dwarf-mistletoe platforms (Franklin 1988, Whitfield et al. 1995).

There was few specific descriptions of juvenile great gray owl habitat use or preferences in the literature. Newly fledged juveniles, are agile, flightless climbers. They use their feet, wings and bills to move throughout their habitat (Mikkola 1983). Young great grays require forest stands with small, deformed, or leaning trees (Franklin 1987, 1988). During the heat of summer, juveniles avoid sunlight and seek shade by frequenting trees with a dense canopy (Bull and Duncan 1993).

Nero (1980) suggests that great gray owls hunt in open, grassy habitats and avoid timbered stands, but Bull and Henjum (1990) found that hunting adults actually preferred to hunt in open forests with canopy closures of 11-59%. In the eastern half of Targhee National Forest, clearcuts were favored over other foraging habitats, although open canopy lodgepole pine and aspen forests were also used (Whitfield et al. 1995).

Detection Methods

Like other raptorial species detection of great gray owls can be enhanced with the use of broadcast conspecific calls. Generally surveys using calls should be started in March, continuing into the end of April. In years when deep snows persist into the spring vocalization surveys should be delayed since great gray owl may delay their courtship when such conditions occur. Surveys should be performed 3-4 hours after dusk. Evening surveys are preferable to early morning surveys. Young owlets can be detected with the use of conspecific food-begging vocalizations from early July to mid August, a period in which they are particularly vocal. The earlier young owlets are detected after fledging, the more likely they will still be in close proximity to the nest. Adults are territorial within close proximity to the nest and thus the further away from the nest the less likely an adult can response can be elicited with taped calls (USDA 1993).

Barred Owl (*Strix varia*)

In the West, barred owls are resident from southeastern Alaska and eastern British Columbia into the northwestern states in the interior Rockies to northern California (Johnsgard 1988). They are now rarely found into southeast Idaho, western Montana, and northwest Wyoming. Barred owls in the East are found from Nova Scotia to Central Alberta across Canada, and throughout the eastern and southeastern United States.

The barred owl is a forest-dependent owl, and has suffered in areas where forests have been extensively cut. In areas where forest habitats are relatively small in size, barred owls may be excluded by much larger great horned owls. However, the barred owl does appear more adaptive than some other species. Barred owl populations have greatly expanded their range into the Northwestern U. S. since the 1960s, and are now found in many habitats formerly occupied by spotted owls (Hamer and Allen 1985). Barred owls occur into southeast Alaska, and into our region in southern Idaho and Northwest Wyoming.

Local Occurrence

The closest documented occurrence of a barred owl is in the Centennial Mountains along the continental and state divides between Montana and Idaho. They have also been reported in northwestern Wyoming. Their documented range expansion suggests that barred owls may be found within our study area.

Reproductive Biology

Courtship begins in winter, as the pair exchanges hoots, and males pursue females with a variety of calls and displays and courtship feeding and preening (Johnsgard 1988). Barred owl calls are highly distinctive: "Who cooks for you; who cooks for you all"?

Barred owls might be expected to initiate nesting in early April to May at our latitude. They have a relatively long breeding season, and will often renest following egg or brood loss (Johnsgard 1988). Females do all the incubation and brooding, whereas males bring in the food. Clutch sizes are relatively small, on average 2.4 eggs/clutch (Murray 1976). Yearly variations in clutch size are influenced by prey base and winter severity. Incubation begins with the first egg laid, which equates to staggered hatching. Incubation lasts 28 to 33 days. Average number of nestlings is about 2 (Apfelbaum and Seelbach 1983). Young grow rapidly in the first month. At 4-5 weeks, the young regularly leave the nest to climb into nearby trees and hide in branches. Young begin to fly at about 6-7 weeks old. They may receive some food from adults for up to 4 months.

Barred owls are thought to have permanent pair bonds, which persist year around, but this feature is not well known. They are fairly sedentary and territorial much of the year, although mostly solitary from July to early December. There is a high degree of nest tenacity and territoriality. The owls are relatively long-lived, with records of up to 10 years in the wild. Barred owl occupancy of nest territories has been documented for over 30 years.

Ecology and Habitat Relationships

Barred owls typically breed within dense, mature woodlands, varying from uplands to lowland swamps, but especially wetland areas in deep woods (Nicholls and Warner 1972, Elody and Sloan 1985). Nesting territories are usually in mature and dense mixed deciduous/conifer forests, often near water. Nests are most often in a cavity in a large tree (roughly 50 cm or about 20 inches dbh or larger), often in a deciduous tree. The owls use natural cavities or old squirrel or hawk nests. Nest heights ranged from 14 to 32 feet in eastern Canada. Often nests are near forest openings, and sometimes in the tops of hollowed tree stubs. Day roosts are typically in areas of maximum daytime concealment in densely foliated trees.

Barred owls prefer open hunting areas, forest edges, and also woodlands or areas with scattered trees and a lack of brush. They often hunt in marshes (Bosakowski et al. 1987). Older forests are preferred because they provide more sub-canopy flying room. Older growth forests also may contain an abundance of down trees that provide rodent habitat. Barred owls are opportunistic foragers; they adapt to local conditions, and take many kinds of prey. Prey items include a large variety of mammals and birds, with average mammalian prey sizes in the range of partially grown cottontails, voles, shrews, and birds the size of flickers, but up to grouse, pheasants, and even long-eared owls. They are semi-nocturnal to nocturnal hunters with hunting techniques and prey preferences that cause strong overlap with spotted owls.

Average barred owl home range sizes were 231 hectares in a Minnesota radio-telemetry study (Nicholls and Warner 1972) and 282 hectares in a Michigan radio-tracking study (Elody and Sloan 1985). Only about 118 hectares of that area was used in summer when the prey base was more dense. Barred owls are strongly defensive of territories (Nicholls and Fuller 1987). They are generally sedentary, but some migratory movements are noted in more northern areas during winter. The owls, particularly the females, may occupy their territories most of the year.

Detection Methods

Barred owls are highly vocal during their nesting period and will respond to taped conspecific calls. In suitable nesting habitat, careful listening will often be sufficient to determine presence of this owl because they call frequently

during the early evening hours (1900-2400). Use of broadcast calls as described for great horned owls applies following the specific nesting chronology and within suitable habitat for barred owls.

Flammulated Owl (*Otus flammeolus*)

The flammulated owl nests locally from southern British Columbia through the interior mountains of western United States into Mexico. This species has not been reported west to the Pacific coast ranges (McCallum 1994). Thought to be migratory, though lacking data from marked birds, the flammulated owl has been observed in the winter in Mexico south to Guatemala and El Salvador (Winter 1974, Johnsgard 1988). The species is associated with mid-elevational open ponderosa pine, Douglas fir, and successional aspen forests (Reynolds and Linkart 1987a). The population status of this species is not well understood, in part because it is highly nocturnal, a cavity nester and migratory (Marcot and Hill 1980). It has more recently been described as an abundant raptor species in some areas (McCallum 1994). It is listed as a sensitive species in Idaho by the U. S. Forest Service, and a species of special concern by Idaho Department of Fish and Game.

Local Occurrence

We have found this species within the study area in Douglas-fir/aspen communities along the South Fork just outside of our immediate sample areas. We have documented nesting season use of one BLM area from 1992-1994. We expect flammulated owls to nest in mixed forests that feature Douglas fir and aspen on relatively dry, foothill areas. Habitat suitable for flammulated owls occurs around the fringes of the study area on BLM holdings and the lower edge of the national forest.

Reproductive Biology

Singing birds have been documented on summer habitat by late April and early May (Reynolds and Linkhart 1987b, Cannings and Cannings 1982, Bull et al. 1992). Flammulated owls initiate incubation in the western Rockies from May through June (Bent 1938, Bull and Anderson 1978, Reynolds and Linkhart 1987a, McCallum 1994). In 1992-94, we have heard singing flammulated owls, presumably courting males, throughout June (unpaired males have been heard singing) (Goggan 1986, Reynolds and Linkhart 1987b). Clutches average 2-4 eggs. Flammulated owls incubate for approximately 22-25 days, mid-June to early July (Goggans 1986, Reynolds and Linkhart 1987a), and the young fledge about 25-32 nights after hatching (Goggans 1986, Reynolds and Linkart 1987a). The young are fed by the adults for another 35-40 nights after fledging, and then begin to disperse from their natal areas in mid- to late August. The adults likely depart from the region by mid-October (Reynolds and Linkhart 1987a). Flammulated owls have been described as having low reproductive rates (McCallum 1994). To date, we have not found any flammulated owl nesting cavities.

Ecology and Habitat Relationships

This species is a secondary cavity nester using cavities excavated by pileated and other large woodpeckers, northern flickers and sapsucker (Bull et al. 1990) and natural holes in snags in aspen or conifers. Most evidence points to the flammulated owl as primarily preying on invertebrates, particularly lepidoptera (butterflies and moths), orthoptera (grasshoppers), and coleoptera (beetles) during the summer months. During the cold temperature periods of spring, noctuid moths are seen as the only available food source to flammulated owls (Reynolds and Linkhart 1987a). Flammulated owls favor old ponderosa pine and Douglas-fir forest and south facing slopes, ridges and plateaus (Marcot and Hill 1980, Goggan 1986, Bull and Anderson 1987, Howie and Ritcey 1987, Reynolds and Linkhart 1987a, Bull et al. 1990). This preference is thought to be linked to prey availability as dry site Dou-

glas-fir and pine have an abundance of lepidoptera (Reynolds and Linkhart 1992). The open-stem nature of these sites is thought to enhance foraging, which is performed by aerial insect hawking and needle gleaning (Linkhart 1984). Goggan (1986) also identified foraging along forest edge grass areas. Summer roosts have been located in dense mixed conifer forests and regeneration stands which often have dense, sprawling forms (Goggan 1986, Howie and Ritcey 1987). Population densities, in general, do not exceed 1 territory per 40 ha (McCallum 1994). Post incubation and pre-fledging home ranges have been estimated at 10 to 14 ha, respectively (Goggans 1986, Reynolds and Linkhart 1987a). Flammulated owls have been referred to as "loosely colonial"; this behavior is disputed and unsubstantiated by actual nest location data (McCallum 1994).

Detection Methods

Flammulated owls are surveyed by ground and the use of conspecific territorial adult calls. Since flammulated owls are thought to be neotropical migrants, surveys are initiated upon their arrival in approximately late April. Detection of breeding flammulated owls starts with broadcasting the territorial vocalization of adult territorial males from early May through June and possibly to the end of July (Reynolds and Linkart 1984, USDA 1993). Broadcast calls should be played from 1/2 hour before dusk and into the night for about 3 hours. Broadcast calling is valuable in determining presence of species. Absence is much more difficult to determine and should not be inferred from survey data until at least 3 years of systematic surveying has been conducted within the same area. Since non-breeding males may respond more than nesting, territorial males, breeding status of responding owls cannot be determined without follow-up ground surveys for nests or young owlets (Reynold and Linkart 1984, Hayward 1989). The chances of locating nests can be enhanced by listening for the food solicitation (begging) call of the female and response call of the male, since both are generally found within the vicinity of nests prior to egg laying.

Nests searches are performed as a follow-up to surveys that detect calling flammulated owls. All song-trees from which calling flammulated owls are heard should be marked and mapped. Triangulation of points and multiple vocalizing owls will help pinpoint each location. Upon returning to these marked song-trees, cavities with entrances greater than 4 cm in diameter are located. Occupancy of a cavity is determined with 10-15 minute observations during the first three hours after dusk. Look for approaching males as they bring food to a vocalizing female. Young owlets close to fledging age can be quite vocal and detection of their food begging calls can direct an observer to the adults. The nest may also be located as young owls stayed within 100 m of their nest upon first fledging (Reynolds and Linkart 1984). Young owlets will continue to move out from the nest site as time passes. The rate of movement is thought to be dependent upon availability of food resources and is thus not determinant.

Flammulated owls have low, soft calls and therefore broadcast calls should be used only on still nights when there is no precipitation, wind or other sound (automobiles, barking dogs or coyotes). Calling stations should be placed 600-800 m (.5 miles) apart and no closer than 400 m (.25 miles), even in broken topography. Territory boundaries have been located along ridge tops and thus survey routes can be placed along similar features. Placing calling routes along ridge tops may increase the projection of the vocalization to both owls and surveyor, ease travel, and may expose the surveyor to more than one territory.

Over-estimation of owl numberss can occur should a vocal owl follow the observer and his tape player along the transect. If using broadcast vocalization tapes to determine habitat relationships, one must be aware that vocalization tapes may pull an individual owl out of its territory and preferred habitat.

Northern Saw-Whet Owl (*Aegolius acadicus*)

The northern saw-whet owl is endemic to North America (Holt et al. 1991). The northern saw-whet owl is found across southeastern and central Canada, into the United States from the northeastern states, Great Lake states to the western states and into southeastern Alaska (Johnsgard 1988). Saw-whets use low elevation riparian habitats which are dominated by deciduous forests as well as high elevation coniferous forests into the spruce-fir zone (Cannings 1987, Palmer 1986). As with other small, mostly nocturnal, cavity nesting owls there is a notable lack of information on the population status of this species. The northern saw-whet owl is not listed as a species of concern.

Local Occurrence

We expect saw-whet owls to nest in riparian deciduous forests in cottonwood and aspen along major stream corridors and in mixed spruce-fir and Douglas-fir communities around the foothills. Saw-whets have been heard in the study area within cottonwood and Douglas-fir habitat types between 5,400 and 6,000 feet in elevation.. Many of our sample areas have potential nesting habitat, though we detected northern saw-whet owls in only two sample sections.

Reproductive Biology

The northern saw-whet owl nests in cavities excavated by northern flickers, hairy woodpeckers, man-made boxes and natural cavities. These owls often nest in aspen or cottonwoods. We have extrapolated data from studies performed in other regions to arrive at the following nesting phenology (Cannings 1987, Palmer 1986, Marks et al. 1989). Nesting activities, including egg laying, may start as early as March in our area. Annual climatic conditions can cause some variation in the exact dates of egg laying. Second clutches may be laid as late as mid-May (Cannings 1987). Clutch sizes range from 4-7 eggs per nest with 5 eggs being the average. Hatching is asynchronous with incubation starting after the laying of the second egg and lasting 27-29 days (early to mid-April in our area). The nestling period lasts from 29-36 days or until late May to early June. The brood is provided food during the incubation and nestling period by the attending male (Marks et al. 1989).

Ecology and Habitat Relationships

Second to the great horned owl, the northern saw-whet is expected to be the most common owl in the study area. Its habitats include low elevation deciduous forests to higher-elevation (>7200') coniferous forests. Nesting owls are expected in aspen, cottonwood, Douglas-fir and lodgepole pine stands. The saw-whet owl is a secondary cavity nesting species, utilizing natural, excavated and man-made cavities. Home ranges have been documented at 142-159 ha (Cannings 1987) (these measurements come from a study utilizing nest boxes). Based upon calling owls, a maximum density of 1 pair per 40 acres has been documented (Swengel and Swengel 1987). The northern saw-whet owl is tightly associated with small mammalian prey. Numerous studies identify deer mice as a dominate prey item in the diet of non-nesting saw-whets, followed by voles (Microtus sp.), shrew (Blarina and Sorex sp.) (Holt et al. 1991, Marks et al. 1989, Swengel and Swengel 1987). Marks and Dorneus (1988) found mice to be the most numerous prey item (by number) used by breeding northern saw-whets. However, meadow voles provided the greatest biomass. Small birds such as pine siskins and sparrows and invertbrates are less important saw-whet prey.

Detection Methods

Broadcast vocalizations of territorial adults and food-begging juveniles are used to survey for the presence and reproductive status of sa-whet owls. The method is as described for flammulated owls with modification to the spe-

cific habitat and nesting chronology of sawwhet owls (Appendix A, Table 3). The cavity nests are located using the same technique also described for flammulated owls. As a general rule, territorial calling ends around the end of April with some annual exceptions. Wind and precipitation can restrict calling activity (Palmer 1987).

Boreal Owl (Aegolius funereus)

Boreal owls range across the boreal forest zone of North America from the Pacific to the Atlantic coast through Canada and United States. In the U.S., the boreal is known to occur from Alaska across to the extreme northern tier states. Only recently has the boreal owl been documented as breeding in Washington, Idaho, Montana, Wyoming, Colorado and New Mexico (Hayward and Garton 1983, Palmer and Ryder 1984, Hayward et al. 1987, Whelton 1989, Stahlecker and Rawinski 1990). Boreal owls may be found further south in winter after going through eruptive movements in response to prey availability. They generally, however, winter within their breeding range. Due to the birds mostly nocturnal nature and use of inaccessible habitats, its population status is poorly known. The boreal owl is listed as a sensitive species by the Forest Service and BLM and a species of special concern by the Idaho Department of Fish and Game.

Local Occurrence

Boreal owls have not been detected in the study area, which may be lower than their normal elevational range of over 7500 feet. Potential boreal owl habitat is thought to occur above the river corridor in the high elevation conifer forest. The closest known occurrence of boreal owls to the study area is approximately 5 miles north of the Snake River corridor towards Teton Basin.

Reproductive Biology

Territorial singing males can be heard as early as mid-February in our area. Depending upon the particular year, they may continue singing until pair formation has occurred or when nesting is no longer feasible (Bondrup-Nielsen 1984). Unpaired males may continue singing late into the nesting season. Courtship flights and mate-feeding may occur in the nesting territory 1-3 months prior to nesting. Nest site occupancy ranged from 13-30, April in Central Idaho (Hayward 1989). Extrapolation of data from Colorado and Central Idaho suggests egg laying could occur between early April to mid-May (Hayward 1994). Incubation lasts approximately 29 days. Dramatic variations in clutch sizes occur between geographic areas and years. These variations are attributed to fluctuating annual prey populations. In Idaho, Hayward (1983), documented a range of 2.5 to 3.5 eggs per nest. The nestling period lasts 28-36 days. Young owlets are independent of the adults after another 5-6 weeks. The mean number of young fledged in the Central Idaho study area was 2.3 young. Studies on European boreal owl populations have documented the mean number of young fledged at 3.4 to 3.9 per successful nest. Boreal owls are mostly monogamous through the duration of the nesting season. Polygamy occurs in European boreal owl populations when vole populations are high. Prey populations are thought to effect the first age of breeding, clutch size, fledging success, seasonal dispersal and nomadic movements.

Ecology and Habitat Relationships

Habitats used for nesting include aspen intermixed with conifer (Eckert and Savaloja 1979), and mature and late successional conifer subalpine-fir forest type (Hayward et al. 1993) including spruce, Douglas-fir, subapline fir, western hemlock and lodgepole pine forests. Boreal owls are secondary cavity nesters. They utilize the cavities excavated by northern flickers and pileated woodpeckers. Nests are generally located in large diameter trees (x dbh = 33-112 cm) or snags (Hayward 1994). Nest cavities are thought to be a limiting factor in some ranges

(Hayward 1994). Hayward found boreal owls nesting at the lower elevation of a territory in aspen/conifer areas where cavities are more likely to occur and roosting and foraging in higher elevation subapline fir forests. Roosts sites do change between winter and summer seasons (Hayward 1994). Artificial nest boxes have been used by boreal owls. Nest boxes have been used to gather demographic and life history information on certain boreal populations.

Boreal owls mostly hunt at night using a sit and pounce strategy as opposed to a chase pursuit. Small mammals make up the majority of their diet including red-backed voles, microtines, northern bog lemmings, deer mice, shrews, flying squirrels, and northern pocket gophers. Small birds such as robins, mountain chickadees, kinglets and redpolls may also be taken (Palmer 1986, Hayward and Garton 1988). Prey taken varies with seasonal and annual availability.

Home ranges of boreal owls in Colorado have been documented at 1,395 to 1,576 ha (Palmer 1986). Considered minimums, boreal home ranges are documented at 1,451 ha in the winter and 1,182 ha in the summer (Hayward et. al. 1993). There are no accurate population densities of boreal owls in North America. Territorial singing by males and other behaviors are thought to be confined to within a 100 m radius of the nest cavity and within the courtship and breeding period (January to July) (Hayward 1994)..

Detection Methods

The use of broadcast territorial calls of the adult male have been successfully used to determine presence of boreal owls. The same technique described for flammulated owls applies. The courtship period is thought to end at approximately the time that nighttime temperatures remain above 0 degrees centigrade. Boreal calling starts by mid-January and can continue until the end of June (Palmer 1987) (Appendix A, Table 3). The combination of precipitation and wind can restrict calling activity (Palmer 1987). In the Island Park area of southeast Idaho, we detected juvenile food-begging calls as late as early August.

Nest boxes have been used to collect information on the population demographics of boreal owls (Hayward et. al. 1992). Hayward concluded that: 1) long term monitoring of nest boxes must be established before owl demography can be related to habitat changes; 2) the relationship between a larger owl population and those using nest boxes must be examined before trends can be inferred; and 3) the use of nest boxes is expensive and intensive but it does produce relatively precise estimates of occupancy and productivity when nest box occupancy exceeds 65%.

Northern Pygmy-Owl (*Glacidium gnoma*)

Residents of western North America, the northern pygmy owl distribution extends from southeastern Alaska west into British Columbia south to western Mexico and Guatemala. The northern pygmy owl is a resident of forested habitat from the foothills to higher elevations (Reynolds et al. 1989). These owls are not thought to be migratory though they may undergo an elevational shift in habitat between summer and winter. The European pygmy owl (*Glacidium passerinum*) has also shown irruptive movements in Fenno-Scandia (Mikkola 1983). The diminutive size of this species and its nocturnal habitats have resulted in few nests being found and thus little information on this species exists (Holt and Norton 1986). The northern pygmy is probably more commonly seen during winter months when it frequents more urbanized areas in search of prey at bird feeders. Little is known about the nesting habitat, territories or population trends of this small owl.

Local Occurrence

The northern pygmy owl occurs in the study area. We heard a singing male at a Douglas-fir/cottonwood interface within the South Fork canyon in 1992 outside of our selected sample areas. B. Alford (pers. comm.) reported a

singing adult in conifer stands east of the sample area in Sheep Creek. Suitable breeding and winter habitats are found throughout most of the study area.

Reproductive Biology

Reproductive information for the pygmy owl is taken from similar habitat areas outside of southeastern Idaho, because we have not found any information specific to Idaho. Colorado, Montana and Arizona studies report egg-laying to occur from early April to mid-May (Holt and Norton 1986, Johnsgard 1988). The study of one nest in NW Montana found egg laying to occur between April 3-15, incubation started April 15 and hatching occurred May 15 (Holt and Norton 1986). Incubation is estimated at 28-30 days. The northern pygmy is one of the few owls that has synchronized incubation and thus hatching occurs over an interval of only 1-2 days. Asynchronized hatching has also been documented (Holt and Notron 1986). Clutch sizes range from 3-6 eggs. Within 25 days the young owlets are fully feathered and fledge at 23-30 days. Nests have been found in dead and live Douglas-fir, ponderosa pine, aspen, grand fir and Western red cedar. Nest cavities used by pygmy owls have been excavated by sapsuckers and northern flickers (Bull et al. 1987). The European pygmy uses cavities excavated by northern three-toed woodpeckers (Mikkola 1983).

Ecology and Habitat Relationships

The northern pygmy resides in a variety of habitat types ranging from oak savanna to mixed montane coniferous forests. Nests may be found near openings such as meadows, partially timbered sites or wetlands (Reynolds et al. 1989). Such locations are thought to be associated with foraging habitat. They are typically not found in continuous forests territories but near clearings, meadows, open water or other such openings (Verner and Boss 1980). This owl is associated with low elevation habitat but does range into higher elevation mountain areas (Reynolds et al. 1989). Male northern pygmies defend large territories year round and may be assisted in this defense by its mate, thus earning the description of "unsociable" owls. As with the flammulated owl, territories are thought to course natural topographic features such as ridges. There is almost nothing known about the territory and dispersal of this owl species. After following a singing male pygmy owl in northern Mexico and southern Arizona, Marshal (1957) described the their territory as "immense" (Reynolds et al. 1989). The northern pygmy owl feeds on small mammals such as shrews, mice, and voles and small nuthatches, flycatchers and finch-size birds. Pygmy owls have also been documented to kill large prey such as red squirrels, young chicken and quail, although they were unable to lift them into the air, and had to feed upon them in place (Holt and Norton 1986). Ouside of the nesting season, hunting takes place during the crepuscular hours of the day and is accomplished by surprise and pursuit on the wing. Because of the large territory of this species, they occur at relatively low densities throughout their range.

Detection Methods

Often in the winter this small owl can be easily observed in urban areas and at bird feeders where they are drawn to potential prey. During the nesting season, however, the pygmy is similar to other small cavity nesting owls in its secretive behaviors. The use of conspecific broadcast calls are used to detect presence of this species during its breeding season (April though early June). We have heard territorial vocalization of the northern pygmy along the river corridor in early June. The European pygmy has been heard vocalizing it's territorial call throughout the year but more so during March to May (Mikkola 1983). Mikkola (1983) describes the European pygmy owl as highly vocal and as strongly attracted to imitated calls. Protocol for using taped calls follows that presented for the flammulated owl. Observed mobbing by small birds can be an attractant to finding pygmies.

Discussion

Raptors have long been noted as sensitive indicators of environmental change, and are often the first species to show the effects of habitat alteration, particularly in insular habitats (Wilcox 1987). There are several detailed studies of individual raptor species in the Greater Yellowstone Ecosystem, e. g. Franklin 1987, and assemblages of 2 or 3 interacting species, e. g. Restani 1989. However, we know of only one long-term study of the entire assemblage of raptors, the notable research conducted by John and Frank Craighead and associates in Jackson, Wyoming (Craighead and Mindell 1981.). Our interest is to develop a baseline record of the raptor community in the Snake River study area and to initiate long-term monitoring. We are hopeful that this information will be used by planners in on-going efforts to conserve the area's unique qualities and natural resources. We anticipate that this growing data base will also have value for the conservation of raptorial birds beyond our geographic area of interest. The statistical methods developed here should be applicable to many species and other levels of biological diversity.

Species of concern

Several of the raptor species noted here have special designations because of perceived vulnerability to species decline. The bald eagle and peregrine falcon are listed as threatened and endangered species by the federal U. S. Fish and Wildlife Service. The northern goshawk and ferruginous hawk are listed as category 2 species, species for which listing as endangered or threatened species may be appropriate, but for which conclusive data on species vulnerability is lacking. Species listed as sensitive or rare by state and/or federal agencies for the region include the Swainson's hawk, flammulated owl, northern pygmy-owl, burrowing owl, great gray owl, and boreal owl. Little is known about the population status of the small forest owls, particularly the flammulated, northern pygmy, and boreal owls. The flammulated owl and Swainson's hawk are neotropical migrants; species which annually migrate south to winter habitats in Mexico/Guatemala and South America, respectively. There is serious concern with the status of many neotropical land migrants because of notable population declines (Terborgh 1989).

Comparative Study

Impacts to raptor communities occur at varying spatial scales from individual breeding territories to continents and beyond for migratory species. Recent tracking of Swainson's hawks, for example, has discovered large scale losses of hawks due to pesticide use in wintering grounds in Argentina (Woodbridge pers. comm.).

Effects of habitat modification

Many will acknowledge that habitat modification is a two sided-coin: both negative and positive effects can result. The Snake River study area today is vastly different from its condition before settlement. For example, shrub-steppe communities, sage and mountain brush, have been altered by grazing and cultivation (see Young and Sparks 1985). Aspen woodlands have greatly diminished due to cattle grazing and clearing. Riparian communities of great significance to birds of prey have changed because of altered stream flow and fire control (Lee et al. 1987). The current housing boom in the Greater Yellowstone Region may be leading to yet another major change in local habitats.

Habitat changes affect raptor populations in three primary ways: 1) positive or negative influences on direct mortality, 2) loss or gain of potential nesting habitat, and 3) altered prey availability. Human induced direct mortality arises chiefly from toxic chemicals, shooting, collisions, electrocution, and disturbance at critical times in nesting. These factors are relatively easy to control, with the possible exception of toxic chemicals, because problems are often very specific and local.

Impacts to nesting habitat may be more

general. For example, changes in ground cover due to cultivation, grazing or other disturbances can make sites unsuitable for nesting by ground nesting raptors, the harrier and short-eared owl. Human housing development can also influence the abundance of potential nest predators such as raccoons and red foxes. Numbers of both species have increased dramatically in recent years. Cavity nesters like kestrels and small forest owls depend upon the presence of dead or partially dead trees of sufficient size and cavity builders like flickers and woodpeckers. Stick nesters and cliff dwellers all have specific nesting habitat requirements. Owls generally need nest builders, like corvids or red-tailed hawks, because they do not build their own nests.

Prey availability strongly influences raptor productivity and local population size (Garton et al. 1987). Reproductive effort and success often fluctuate in concert with prey populations. Year to year population density may be strongly influenced by prey availability. Raptorial birds are highly mobile; large shifts in seasonal raptor populations such as wintering rough-legged hawks are known to follow prey population changes. Mass raptor population movements have been noted following prey population crashes.

Effects of Land Uses

The multitude of human land uses effect raptor populations both positively and negatively, and raptor habitat needs should be considered in light of potential impacts. We discuss several land uses briefly as follows: grazing, agriculture generally, recreation, timber harvest, toxic chemicals, linear rights-of-way, and urbanization.

A pervasive grazing influence is the effect upon prey distribution and abundance (Kochert 1987). Some prey species favor low levels of cover, and may be more available to foraging raptors if cover is removed. Dense ground squirrel populations are found in heavily grazed areas. On the other hand, many small mammals and birds require vegetative cover. As mentioned earlier, grazing can alter ground cover needed by ground nesting raptors. Heavy grazing can reduce regeneration of suckering trees like aspen and cottonwoods, and thus reduce the long-term availability of nesting trees. Grazing practices that include site specific control of stock numbers, timing, and use can mitigate impacts to raptorial birds.

Agricultural practices that affect prey abundance and raptor foraging opportunity include tillage, planting and cultivation, irrigation, application of chemicals, and harvesting (Young 1987). Many native raptor habitats were replaced by croplands, roads and farmsteads soon after settlement. Primary crops include grains, potatoes, and hay. Cultivated crops are usually taller and denser than adjacent native vegetation, and may prevent raptor foraging or harbor lower prey densities. However, alfalfa hay may support higher densities of prey than native vegetation (Woodbridge 1985). Hayfields are very important raptor foraging habitat. A high proportion of Swainson's hawk foraging occurs in this habitat.

Recreational activities can alter raptor nesting distribution, disturb birds during nesting activities, or force changes in foraging behavior. Some species are tolerant of nearby human activity, e.g. osprey will nest very near to areas used by people. Other species such as bald eagles may be very sensitive to recreational activity that occurs near nesting areas. A key factor in raptor response to human activities is the degree of predictability in the human behaviors. For example, many raptors nest on farmlands where they often see farmers at work, but react strongly to less predictable recreationists who enter nesting areas. Recreational impacts to nesting and foraging raptors can be mitigated by spatial and temporal control of activities.

Timber harvest has altered stands of old growth and mature timber in upper portions of the study area, which are important habitats for forest species such as accipiter hawks and some owl species. These habitat changes have benefited other raptor species with tolerance for more open habitats. Thus, conservation of the full compliment of native forest-dwelling raptors requires better understanding of habitat relationships and

species interactions, inventory of raptor populations, and careful monitoring of the effects of management activities.

DDT and other organochlorine pesticides have been widely implicated in past, and some continuing losses of raptor populations (Risebrough and Monk 1987). Most of these chemicals are no longer in use in the United States. Other pesticides and herbicides currently in use may cause occasional raptor deaths or reduce prey availability.

New power lines and many new access roads are being built in the study area. Linear rights-of-way associated with roadways and powerlines are often the location of raptor mortality associated with collisions or electrocutions. Vegetation alteration during the siting of roads or powerlines can impact raptor habitat. Mitigation measures include careful consideration of sensitive habitats and use of designs that least endanger raptors.

Development of Swan Valley and the Henry's Fork corridor for homesites and other structures has dramatically increased in recent years. As natural and agricultural open space is converted to other uses, raptor nesting and foraging habitats may be lost. Programs that maintain open space in areas of key importance to raptors are needed. For some of the more tolerant raptor species like osprey and kestrels, artificial nesting structures can in part mitigate habitat losses.

Future Study Efforts

Our 1994 effort at presence/absence sampling has led to a much improved sampling regime for 1995. In the future years of this project, we will refine our objectives and methods as discussed earlier in this report to attain a useful monitoring program.

Acknowledgments

This project was primarily supported by the Bureau of Land Manamgment, Idaho Falls District, and Northern Rockies Conservation Cooperative of Jackson Hole, Wyoming. J. Gardetto and K. Aslett of the Bureau of Land Management have been instrumental in getting this project started, and both continue to provide substantial logistcal assistance. P. Curlee on NRCC helped with support and project administration. T. Kaminski of the Targhee National Forest has provided support. B. Alford and Targhee National Forest and J. Naderman of Idaho Department of Fish and Game have opened their files to review. M. Gaffney and M. Gebhardt provided field assistance in 1994.

Bibliography

General

Anonymous. 1986. Raptor population estimates. Coop. Res. Newsletter, Cornel Lab. of Ornithology, Ithaca, 22:3.

Bent, A. C. 1938. Life histories of North American birds of prey, part 2. U. S. Natl. Mus. Spec. Bull. 170:1-482.

Clark, T. W., A. H. Harvey, R. D. Dorn, D. L. Genter, and C. Groves, eds. 1989. Rare, sensitive, and threatened species of the Greater Yellowstone Ecosystem. Northern Rockies Conservation Cooperative, Montana Natural Heritage Program, The Nature Conservancy, and Mountain West Environmental Services., Jackson, Wyo., 153 pp.

Craighead, J. J. and F. C. Craighead, Jr. 1956. Hawks, owls and wildlife. Stackpole Co., Harrisburg, and Wildlife Management Institute, Washington.

Craighead, F. C. Jr. and D. P. Mindell 1981. Nesting raptors in western Wyoming, 1947 and 1975. J. Wild. Manage. 45:865-872.

Garton, E. O., P. H. Hayward, and G. D. Hayward. 1987. Management of prey habitats and populations. Pp. 298-304 *in* B. G. Pendleton, ed., Proc. Western Raptor Manage. Symp. and Workshop, Nat. Wild. Fed. Sci. and Tech. Ser. No. 12, Boise, Id, 317 pp.

Giron Pendleton, B. A., B. A. Millsap, K. W. Cline, and D. M. Bird, eds. 1987. Raptor management techniques manual. Sci. and Tech. Ser. 10, Inst. for Wild. Res., Natl. Wildl. Fed., Wash. D. C.

Jaksic, F. M. 1985. Toward raptor eommunity ecology: behavior bases of assemblage structure. Raptor Research 19:107-112.

Johnsgard, P. A. 1988. North American owls, biology and natural history. Smithsonian Institution Press, Washington, D. C., 295 pp.

Johnsgard, P. A. 1990. Hawks, eagles and falcons of North America, biology and natural history. Smithsonian Institution Press, Washington, D. C., 403 pp.

Mikkola, H. 1983. Owls of Europe. Buteo Books, Vermillion, USA. 397 pp.

Murphy, D. D., and S. B. Weiss. 1988. A long-term monitoring plan for a threatened butterfly. Conservation Biology 2:367-374.

Newton, I. 1979. Population ecology of raptors. Buteo Books, Vermillion, South Dakota, 399 pp.

Sherrod, S. K. 1978. Diets of North American Falconiformes. Raptor Res. 12: 49-121.

USDI, Bureau of Land Management, and USDA, Forest Service. 1991. Snake River Activity/Operations Plan, Final. BLM, Idaho Falls. 101 pp. plus appendices

Inventory and Monitoring Methods

Brown, L.H. and D. Amadon. 1968. Eagles, hawks, and falcons of the world (Vol I and II). McGraw-Hill Book Co., New York, N.Y. 945pp.

Call, M.W. 1978. Nesting habitats and surveying techniques for common western raptors. Tech. Note 316. U.S. Dept. Inter. Bur. Land Manage. Service Center Denver, Co. 115pp.

Fuller, M.R. and J.A. Mosher. 1981. Methods of detecting and counting raptors: a review. Pp 235-246 *in* C.J. Ralph and M.J. Scott, eds. Estimating numbers of terrestial birds. Stud. Avian Biol. 6.

Fuller, M.R. and J.A. Mosher. 1987. Raptor survey techniques. Pp 37-65 *in* B.A. Giron Pendelton, B.A. Millsap, K.W. Cline, and D.M. Bird, eds. Raptor management techniques manual. Natl. Wildl. Fed., Washington, D.C.

Johnson, R.R., B.T. Brown, L.T. Haight, and M.J. Simpson. 1981. Playback recordings as a special avain censusing technique. Pages 68-75 *in* C.J. Ralph and M.J. Scott eds. Estimating numbers of terrestial birds. Stud. Avian Biol. 6.

Kochert, Michael N. 1986. Raptors. Pp 313-349 *in* Cooperrider A.Y., R.J. Boyd, and H.R. Stuart, eds. 1986. Inventory and monitoring of wildlife habitat. U.S. Dept. Inter. Bur. Land Manage. Service Center. Denver, Co. xvii 858pp.

McGarical, K., and J.D. Fraser. 1984. The effects of forest stand age on owl distribution in southwestern Virginia. J.Wildl. Manage. 48:1393-1398.

McKenzie, N. L., A. C. Robinson, and L. Belbin. 1991. Biogeographic survey of the Nullarbor District, Australia. Pp 109-126 *in* Margules and M. P. Austin, eds. Nature conservation: cost effective biological surveys and data analysis, Australia, CSIRO, East Melbourne.

Mosher, J.A., M.R. Fuller, and M.Kopeny. 1990. Surveying woodland raptors by broadcast of conspecific vocalizations. J. Field Ornithology, 61(4) 453-461.

Munholland, P. L. and J. J. Borkowski. 1993a. Latin square + 1 designs. Technical Report. Department of Mathematical Sciences, Montana St. University, Bozeman.

Munholland, P. L. and J. J. Borkowski. 1993b. Adaptive simple latin square sampling + 1 designs. Technical Report. Department of Mathematical Sciences, Montana St. University, Bozeman.

Ollendorf, R.R, D.D. Bibles, M.T. Dean, J.R. Haugh, and M.N. Kochert. 1989. Raptor habitat management under the U.S. Bureau Land Management multiple use mandate. Raptor Research Reports 8:1-80.

Postupalsky, S. 1974. Raptor reproductive success: some problems with methods, criteria, and terminlology. Pp. 21-31 *in* Hamerstrom, F. N. Jr., B. E. Harrell, R. R. Olendorff, eds. Management of Raptors, Raptor Res. Found., Vermillion, S.D.

Saab, Victoria A. 1990. Blackfoot Raptor Inventory. U.S. Dept. Inter. Bur. Land Manage. Boise District Tech. Bulletin 90-2 42pp.

Smith, D. G. 1987. Owl census techniques. Pp 304-309 *in* Nero, R. W., R. J. Clark, R. J. Knapton, and R. H. Hamre eds., Biology and conservation of northern forest owls, Symposium Proceedings., U.S.D.A. Forest Service, Gen. Tech. Report RM-142.

Steenhof, K. and M.N. Kochert. 1982. An evaluation of methods used to estimate raptor nesting success. J. Wildl. Manage. 46:885-893.

Thompson, S. K. 1990. Adaptive cluster sampling. JASA 85: 1050-1115.

USDA, Forest Service. 1993. Region 4 sensitive species. Broadcast vocalization compact disc Payette National Forest: CD use information. Payette N.F. 11pp.

Species Accounts

Bald Eagle

Brown, L. H. and D. Amadon. 1968. Eagles, hawks and falcons of the world. McGraw-Hill, New York, Two vols., 945 pp.

Greater Yellowstone Bald Eagle Working Group. 1983. A bald eagle management plan for the Greater Yellowstone Ecosystem. Wyoming Game and Fish Dept., Cheyenne, 84 pp.

Greater Yellowstone Bald Eagle Working Group. 1993. Productivity report for 1993. Yellowstone National Park, Mammoth, pp.

Henny, C. J. 1983. Distribution and abundance of nesting ospreys in the United States. Pp. 175-186 *in* Bird, D. M., N. R. Seymour, and J. M. Gerrard eds., Biology and Management of Bald Eagles and Ospreys, Raptor Res. Found., Harpell Press, Ste. Anne de Bellevue, Quebec, 325 pp.

Herrick, F. H. 1932. Daily life of the American eagle: early phase. Auk 49:307-323.

Lincer, J. L., W. S. Clark, and M. N. LeFranc. 1979. Working bibliography of the bald eagle. National Wildlife Fed., Washington, D. C., 244 pp.

Swenson, J. E., K. L. Alt, and R. L. Eng. 1986. Ecology of bald eagles in the Greater Yellowstone Ecosystem. Wildlife Society, Wildlife Monograph No. 95, 46 pp.

Thelander, C. G. 1973. Bald eagle reproduction in California, 1972-1973. Wildlife Branch Admin. Report No. 73-5, Cal. Dept. of Fish and Game, Sacramento, 17 pp.

Whitfield, M. B. 1985. Bald eagle (Haliaeetus leucocephalus) nesting habitat management in Southeast Idaho. Raptor Research Foundation, International Meeting, Sacramento, CA., 12 pp.

Whitfield, M. B., S. M. Patla, and P. F. Brussard. 1988. Idaho bald eagle research project, Greater Yellowstone Ecosystem Annual Report, Bureau of Land Managment, Idaho Falls, Idaho, 109 pp.

Whitfield, M. B., S. L. Austin, and G Tomb. 1991. Continental Idaho Population Unit Interim Report. Idaho bald eagle research project, Greater Yellowstone Ecosystem, Bureau of Land Managment, Idaho Falls, Idaho, 104 pp.

Whitfield, M. B., J. Naderman, R. Jones, R. McFarling, M. Maj, and R. Welch. 1989. Idaho bald eagle research project, Greater Yellowstone Ecosystem, Annual Production Summary 1989, Idaho Department of Fish and Game, Idaho Falls, Idaho, 10 pp.

Whitfield, M. B., S. Austin R. Jones, R. McFarling, J. Naderman, R. Welch, T. Gelatt, J. Kelley, G. Worden and M. Maj. 1990. Idaho bald eagle research project, Greater Yellowstone Ecosystem, Annual Production Summary 1990, Idaho Department of Fish and Game, Idaho Falls, Idaho, 16 pp.

Whitfield, M. B., G. Tomb, S. Austin, M. Maj, A. Giles J. Naderman, R. McFarling, J. Gardetto, K. Aslett, R. Welch, J. Kelley, G. Worden, T. Gelatt, and B. Alford. 1991. Idaho bald eagle research project, Greater Yellowstone Ecosystem, Annual Production Summary 1991, Idaho Department of Fish and Game, Idaho Falls, Idaho, 18 pp.

Whitfield, M. B., S. Austin, M. Maj, P. Mund, J. Rappold, J. Naderman, R. McFarling, J. Gardetto, K. Aslett, D. Stricklan, R. Welch, J. Kelley, G. Worden, and B. Alford. 1992. Idaho bald eagle research project, Greater Yellowstone Ecosystem, Annual Production Summary 1992, Idaho Department of Fish and Game, Idaho Falls, Idaho, 18 pp.

Whitfield, M. B. 1993. South Fork Snake River, final report. Idaho Bald Eagle Research Project. U. S. D. I. Bur. of Land Manage., Idaho Falls, Idaho, 92 pp. plus appendices.

Whitfield, M. B., M. Maj, A. L. Whitfield, A. Harvey, J. Naderman, R. McFarling, J. Gardetto, K. Aslett, R. Welch, J. Kelley, N. Hoffman, and B. Alford. 1993. Idaho bald eagle research project, Greater Yellowstone Ecosystem, Annual Production Summary 1993, Idaho Department of Fish and Game, Idaho Falls, Idaho, 14 pp.

Whitfield, M. B., M. Maj, J. Naderman, R. McFarling, J. Gardetto, K. Aslett, N. Doyle, R. Welch, N. Hoffman, and B. Alford. 1994. Idaho Portion of the Greater Yellowstone Ecosystem, Annual Productivity Report 1994, Idaho Department of Fish and Game, Idaho Falls, Idaho, 16 pp.

Golden Eagle

Beecham, J. J. and M. N. Kochert. 1975. Golden eagle breeding biology, Idaho. Wilson Bull. 87:506-513.

Hobbie, J. E., and T. J. Cade. 1962. Golden eagle breeding in Alaska. Condor 64:235-237.

Matchett, M. R., and B. W. O'Gara. 1987. Controlling golden eagle depredation on domestic sheep J. Raptor Res. 21:85-94.

McGahan, J. 1968. Ecology of the golden eagle. Auk 85:1-12.

Phillips, R. L. 1985. Current issues concerning managment of golden eagles in the West. 1985 Raptor Research Foundation, International Meeting, Sacramento, CA.

Scott, T. A. 1985. Population change of golden eagles in San Diego County from 1928-1978. 1985 Raptor Research Foundation, International Meeting, Sacramento, CA.

Smith, D. G., and J. R. Murphy. 1973. Breeding ecology of raptors in Utah. Brigham Young Univ. Sci. Bull. Biol. Ser. 18:1-76.

Steenhof, K., M. N. Kochert, and R. N. Lehman. 1991. Raptor nesting densities and reproductive success in the Snake River Birds of Prey Area, 1991. Pp. 13-36 *in* Steenhof, K. ed., Snake River Birds of Prey Research and Monitoring Annual Report, U.S.D.I. Bureau of Land Manage., Boise District, Boise, 261 pp.

Osprey

Van Daele, L. J., H. A. Van Daele, and D. R. Johnson. 1980. The status and management of ospreys nesting in Long Valley, Idaho. U.S. Water and Power Resources Service, Proj. Report, Univ. of Idaho, Moscow, 49 pp.

Swenson, J. E. 1979. Factors affecting status and reproduction of ospreys in Yellowstone National Park. Journal of Wild. Manage. 42:87-90.

Swenson, J. E. 1981. Status of the osprey in southeastern Montana before and after the construction of reservoirs. Western Birds 12:47-51.

Poole, A. F. 1989. Ospreys: a natural and unnatural history. Cambridge University Press, New York, 246 pp.

Turkey Vulture

Coleman, J.S. and J.D. Fraser. 1989. Habitat use and home ranges of black and turkey vultures. J. Wildl. Manage. 53: 782-792

Hubbard, J.P. 1983. Roadside raptor counts as an indicator of the status of the turkey vulture in New Mexico. Pp. 375-384 *in* Vuture Biology and Management. ed. S.R. Wilbur and J. A. Jackson. Univ. of Calif. Press.

Jackson, J.A. 1983. Nesting phenology, nest site selection, and reproductive success of black and turkey vulures. Pp. 245-270 *in* Vulture Biology and Management. ed. S.R. Wilbur and J.A. Jackson. Univ. of Calif. Press.

Pattee, O. H. and S.R. Wilbur. 1987. Turkey vultures and California condors. Pp. 61-65 *in* Proceedings of the western raptor management symposium and workshop. National Wildlife Federation, Boise Idaho. Scientific and Technical Series No. 12

Rabenol d, P.P. 1983. The communal roost in black and turkey vulture-an information center? Pp 303-321 *in* S.R. Wilbur and J.A. Jackson, eds., Vulture Biology and Management, Univ. of Calif. Press.

Robbins, C.S , D. Bystrak, and P.H. Geissler. 1986. The breeding bird survey: its first fifteen years, 1965-1979. U.S. Fish and Wildl. Ser. Resour. Publ. 157. Washington D.C. 196 pp.

Thompson, W.L., R.H. Yahner, and G.L. Storm. 1990. Winter use and habitat characteristis of vutlure communal roosts. J.Wildl. Manage.. 54: 77-83.

Red-tailed Hawk

Andersen, D. E. and O. J. Rongstad. 1989. Home-range estimates of red-tailed hawks based on random and systematic relocations. J. Wild. Manage. 53:802-807.

Gates, J. M. 1972. Red-tailed hawk ecology, Wisconsin. Wilson Bull. 84:421-433.

Harlow, D. L. and P. H. Bloom. 1987. Buteos and the golden eagle. Pp. 102-112 *in* B. G. Pendleton, ed., Proc. Western Raptor Manage. Symp. and Workshop, Nat. Wild. Fed. Sci. and Tech. Ser. No. 12, Boise, Id, 317 pp.

Hereford, S. G. 1982. Nest site habitat and productivity of the red-tailed hawk (Buteo jamaicensis in northwest South Dakota. Unpubl. M.A. Thesis, Univ. South Dakota, 64 pp.

Houston, C. S. and M. J. Bechard. 1983. Trees and the red-tailed hawk in southern Saskatchewan. Blue Jay 41:99-109.

Howell, J., B. Smith, J. B. Holt, and D. R. Osborne. 1978. Red-tailed hawk habitat and productivity. Bird-Banding 49:162-171.

Janes, S. W. 1984. Red-tailed hawk breeding territory fidelity. Condor 86:200-203.

Kirkley, J. S. and M. A. Springer. 1980. Nesting red-tailed hawks and great horned owls in Ohio. Raptor Res. 14:22-28.

Luttich, S. N., L. B. Keith, and J. D. Stephenson. 1971. Population dynamics of red-tailed hawks, Alberta. Auk 88:75-87.

Luttich, S. N., D. H. Rusch, C. Meslow, and L. B. Keith. 1970. Ecology of red-tailed hawks, Alberta. Ecology 51:190-203.

McGovern, M., and J. M. McNurney. 1986. Red-tailed hawk nest densities, Colorado. Raptor Res. 20:43-45.

Moritsch, M. Q. 1983. Photographic guide for aging nestling red-tailed hawks. U.S.D.I., Bur. of Land Manage., Boise District, Idaho.

Swainson's Hawk

Bechard, M. J. 1982. Effect of vegetative cover of foraging site selection by Swainson's hawk. Condor 84: 153-159.

Bloom, P. H. 1980. The status of the Swainson's hawk in California, 1979. Calif. Dept. of Fish and Game, Fed. Aid Wildl. Restoration, Proj. W-54-R-12, 42 pp.

Dunkle, S. W. 1977. Swainson's hawks in Wyoming. Auk 94:65-71.

Fitzner, R. E. 1978. The ecology and behavior of the Swainson's hawk (*Buteo swainsoni*) in southeastern Washington. Ph.D. diss., Washington St. Univ., Pullman.

Herron, G. B. and P. B. Lucas. 1978. Population surveys, species distribution, and key habitats of selected non-game species. Nev. Dept. Fish and Game, Job Perform. Rep., Proj. W-43-R, Study 1, Jobs 1 and 2.

Gilmer, D. S. and R. E. Stewart. 1984. Swainson's hawk nesting ecology in North Dakota. The Condor 86:12-18.

Littlefield, A. D., S. P. Thompson, and B. D. Ehlers. 1984. History and status of Swainson's hawks in southeast Oregon. Raptor Research 18:1-5.

Schlorff, R. W. 1985. Swainson's hawk (Buteo swaisonii) habitat relationships in agricultural regions of California. 1985 Raptor Research Foundation, International Meeting, Sacramento, CA.

Woodbridge, B. B. 1985. Biology and management of Swainson's hawks in the Butte Valley, California. U. S. D. A. Forest Service, Yreka, Ca., 19 pp.

Woodbridge, B. B. 1987. Swainson's hawks and grazing in California. Proc. Ann. Meeting, Raptor Res. Found., Boise, Idaho.

Woodbridge, B. B. 1991. Habitat selection by nesting Swainson's hawks: a hierarchical approach. Unpubl. M.S. Thesis, Oregon St. Univ., 80 pp.

Ferruginous Hawk

Bechard, M.J., R.L. Knight, D.G. Smith, and R.E. Fitzner. 1990. Nest sites and habitat of sympatric hawks (*Buteo* SPP.) in Washington. J.Field Ornithology, 61: 159-170.

Fitzner, R.E., D. Berry, L.L. Boyd, and C.A. Rieck. 1977. Nesting of ferruginous hawks (*Buteo regalis*) in Washington 1974-75. Condor 79:245-249.

Gaines, R.C. 1985. Nest site selection, habitat utilization, and breeding biology of the ferruginous hawk in central North Dakota. MS. Thesis, North Dakota State Univ., Fargo. 32 pp.

Restani, M. 1989. Resource partitioning among three species of hawks in the Centennial Valley, Montana. M.S. Thesis, Mont. St. Univ., Bozeman, 86 pp.

Restani, M. 1991. Resource partitioning among three *Buteo* species in the Centennial Valley, Montana. Condor 93:1007-1010.

Schmutz, J.K. 1984. Ferruginous and Swainson's hawk abundance and distribution in relation to land use in southeastern Alberta. J. Wildl. Manage. 48: 1180-1187.

Thurow, T.L. and C.M. White. 1983. Nest site relationship between the ferruginous hawk and Swainson's hawk. J. Field Ornith., 54:401-406.

USDI, Fish and Wildlife Service. 1992. Endangered and threatened wildlife and plants; notice of finding on petition to list the ferruginous hawk. Federal Register 57: 37507-37513.

Woffinden, N.D. and J.R. Murphy. 1977. Population dynamics of the ferruginous hawk during a prey decline. Great Basin Nat. 37: 411-425.

Woffinden, N.D. and J.R. Murphy. 1989. Decline of a ferruginous hawk population: a 20 year summary. J.Wildl. Manage. 53:1127-1132.

Northern Harrier

Clark, R.J. 1972. Pellets of the short-eared owl and marsh hawk compared. J. Wildl. Manage. 36:962-964.

Craighead, J. and F. Craighead. 1956. Hawks, owls and wildlife. Harrisburg: Stackpole Co.

Johnsgard, P.A. 1990. Hawks, eagles, and falcons: biology and natural history. Smithsonian Institution Press. 403pp.

Martin, J.W. 1987. Behavior and habitat use of breeding northern harriers in southwestern Idaho. J.Raptor Res. 21:57-66.

Martin, J.W. 1987. Harriers and kites. Pp. 83-91 *in* Proceedings of the western raptor management symposium and workshop. National Willdife Federation, Boise, Idaho. Scientific and Technical Series No. 12.

Accipiter Hawks: Goshawk, Cooper's Hawk, Sharp-shinned Hawk

Bosakowski, T., R.Speuser, D.G. Smith, and L.J. Niles. 1993. Loss of Cooper's hawk nesting habitat to suburban development: indadequate protection for a state-endangered species. J.Raptor. Res. 27:26-30.

Bloom, P.H., G.R. Stewart, and B.J. Walton, 1986. The status of the northern goshawk in California 1981-1983. California Dept. Fish and Game, Wildl. Manage. Branch, Adm. Rep. 85-1.

Hargis, C.D. 1994. Home ranges and habitats of northern goshawks in Eastern California. Stud. in Avian Biol. 14 pp.

Henny, C.J., R.A. Olson, and T.L. Fleming 1985. Breeding chronology, molt, amd measurements of accipiter hawks in Northeastern Oregon. J.Field Ornith. 56: 97-212.

Herron, G.B. , C.A. Mortimore and M.S. Rawlings. 1985. Nevada raptors, their biology and management. Biol. Bull. No. 8, Nevada Department of Wildlife, Reno, NV. 114pp.

Hayward, G.D. and R.E. Escano. 1989. Goshawk nest-site characteristics in western Montana and Northern Idaho. Condor 91: 476-479.

Joy, S. M., R.T. Reynolds and D.G. Leslie. 1993. Northern goshawk broadcast surveys: Hawk response variables and survey costs. Sixty-third Annual Meeting of the Cooper Ornithological Society. Sacremento, CA.

Joy, S.M., R.T. Reynolds, R.L. Knight, and R.W. Hoffman. 1994. Feeding ecology of sharp-shinned hawks nesting in deciduous and coniferous forests in Colorado. Condor 96:455-467.

Kennedy, P.L. and D.R. Johnson. 1986. Prey-size selection in nesting male and female Cooper's hawks. Wilson Bull., 98: 101-115.

Kennedy, P. L. and D. W. Stahlecker. 1993. Responsiveness of nesting northern goshawks to taped broadcasts of 3 conspecific calls. J.Wildlife Manage. 57:249-257.

Kimmel, J.T. and R.H. Yahner. 1990. Response of northern goshawks to taped conspecific and great horned owl calls. J. Raptor Res. 24:107-112.

Moore, K.R. and C.J. Henny. 1983. Nest site characteristics of three coexisting accipiter hawks in Northeastern Oregon. J. Raptor Res. 17: 65-76.

Patla, S. 1991. Northern goshawk monitoring project report #2. 1990. Targhee National Forest, St. Anthony, Idaho, 43pp. plus appendix.

Platt, J.B. 1976. Sharp-shinned hawk nesting and nest site selection in Utah. Condor 78:102-103.

Quinn, M.S. 1991. Nest site and prey of a pair of sharp-shinned hawks in Alberta. J.Raptor Res. 25: 18-19.

Reynolds, R.T., and H.M. Wight. 1978. Distribution, density, and productivity of accipiter hawks breeding in Oregon. Wilson Bull. 90: 182-196.

Reynolds, R.T., E.C. Meslow, and H.M. Wright. 1982. Nesting habitat of coexisting *Accipiter* in Oregon. J. of Wildlife Manage. 46:124-138.

Reynolds, R.T. 1983. Management of western coniferous forest habitat for nesting accipiter hawks. USDA Forest Service Gen. Tech. Report RM-102 7pp.

Reynolds, R.T. and E.C. Meslow. 1984. Partitioning of food and niche characteristics of coexisting *Accipiter* during breeding. Auk 101: 761-779.

Reynolds, R.T. 1989. Accipiters. Pp. 92-101 *in* Proc. western raptor management symposium and workshop. Natl. Wildl. Fed., Washington, D.C.

Reynolds, R.T., R.T. Graham, M.H.Reiser, R.L. Bassett, P.T. Kennedy, D.A. Boyce, G.Goodwin, R. Smith and E.L. Fisher. 1992. Management recommendations for the northern goshawk in the southwestern United States. Gen. Tech. Rep. RM-217. Ft. Collins, CO: USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station. 90p.

Rosenfield, R.N. 1985. Taped calls as an aid in locating Cooper's hawk nests. Wildl. Soc. Bull. 13: 62-63.

Rosenfield, R.N. 1985. Effectiveness of taped calls in detecting nesting Cooper's Hawks (Accipiter cooperii). 1985 Raptor Research Foundation, International Meeting, Sacramento, CA.

Rosenfield, R.N., J. Bielefeldt, R.K. Anderson. 1988. Effectiveness of broadcast calls for detecting breeding Cooper's hawks. Wild. Soc. Bull. 16:210-212.

Rosenfield, R.N., J.Bielefeldt, and J.Cary. 1991. Copulatory and other pre-incubation behaviors of Cooper's hawks. Wilson Bull., 103: 656-660.

Rosenfield, R. N. and J. Bielefeldt. 1991. Vocalizations of Cooper's hawks during the pre-incubation stage. Condor 93:659-665.

USDA, Forest Service. 1993. Survey procedure for northern goshawk on National forest lands in the Pacific Northwest Region. Portland, OR. 12pp.

Wiggers, E.P. and K.J. Kritz. 1994. Productivity and nesting chronology of the Cooper's hawk and sharp-shinned hawk in Missouri. J.Raptor Res. 28: 1-3.

Pergrine Falcon

Bull, J. 1974. Birds on New York state. Doubleday, Garden City, N.Y.

Cade, T.J. 1982. The falcons of the world. Cornell Univ. Press. Ithaca, N.Y. 188 pp.

Platt, S.W., and J.H. Enderson. 1989. Falcons. Pp. 111-117 *in* B.G. Pendleton, ed. Proc. of the Western Raptor Manage. Symp. and Workshop, Sci. and Tech. Series No. 12, Inst. for Wild. Re., Nat. Wild. Fed., Wash., D.C., 320 pp.

Porter, R.D., C.M. White and R.J. Erwin. 1973. The peregrine falcon in Utah, emphasizing ecology and competition with the prairie falcon. Brigham Young Univ. Sci. Bull. 18:1-74.

Prairie Falcon

Becker, D.M., and I.J. Ball. 1983. Prairie falcon (Falco mexicanus). Pp. 138-153 *in* J.S. Armbruster ed., Impacts of coal surface mining on 25 migratory bird species of high federal interest. U.S. Fish and Wild. Ser., FWS/OBS-83/85, Fort Collins, CO.

Boyce, D.A. 1985. Prairie falcon prey in the Mojave Desert, California. Raptor Res. 19:128-134.

Cade, T.J. 1982. The falcons of the world. Cornell Univ. Press. Ithaca, N.Y. 188 pp.

Kockert, M.N., K. Steenhof, D.R. Duncan, M.Q. Moritsch, A.C. Dolde, D.M. Ramirez, S.A. Adams, and D. Delsordo. 1983. Density and reproductive performance of raptors in the Snake River Birds of Prey Area. Pp. 6-15 *in* U.S.D.I. Bur. of Land Manage., Snake River Birds of Prey Ann. Rep., Boise, Idaho.

Marti, C.D., and C.E. Braun. 1975. Prairie falcons in tundra habitats, Colorado. Condor 77: 213-214.

Millsap, B.A. 1981. Distributional status of falconiforms in west central Arizona: with notes on ecology, reproductive success and management. Tech. Note 355. U.S.D.I. Bur. Land Manage. Serv. Cent., Denver, Co., 102 pp.

Peterson, S.R., G.M. Sitter and B.W. James. 1977. Feeding activity and behavior of prairie falcons. Pp. 165-177 *in* U.S.D.I. Bur. of Land Manage., Snake River Birds of Prey Res. Prog. Ann. Rept., Boise, ID, 201 pp.

Runde, D.E., and S.H. Anderson. 1986. Prairie falcon nest sites. Raptor Res. 20:21-28.

Shor, W. 1975. Survival rates of prairie falcons. Raptor Res. 9:46-50.

Squires, J.R., S.H. Anderson and R. Oakleaf. 1989. Food habits of nesting prairie falcons in Campbell County, Wyoming. Raptor Res. 23:157-161.

Merlin

Becker, D.M., and I.J. Ball. 1983. Merlin (Falco columbarius). Pp. 124-137 *in* J.S. Armbruster ed., Impacts of coal surface mining on 25 migratory bird species of high federal interest. U.S. Fish and Wild. Ser., FWS/OBS-83/85, Fort Collins, CO.

Becker, D. M. 1984. Reproductive ecology and habitat utilization of Richardson's merlins in southeastern Montana. Unpubl. M.S. Thesis, University of Montana, Missoula, 62 pp.

Becker, D. M. and C. H. Sieg 1985. Breeding chronology and reproductive success of Richardson's merlins in southeastern Montana. Raptor Research 19:52-55.

Becker, D. M. and C. H. Sieg 1987. Home range and habitat utilization of breeding male merlins, *Falco columbarius*, in southeastern Montana. Can. Field-Nat. 101:398-403.

Cade, T. J. 1982. The falcons of the world. Cornell Univ. Press. Ithaca, N.Y. 188 pp.

Craig, T. H. and E. H. Craig Merlin. Pp 70-71 *in* Clark, T. W., et al., eds. Rare, sensitive, and threatened species of the Greater Yellowstone Ecosystem. Northern Rockies Conservation Cooperative, Montana Natural Heritage Program, The Nature Conservancy, and Mountain West Environmental Services., Jackson, Wyo., 153 pp.

Feldsine, J. W. and L. W. Oliphant. 1985. Breeding behavior of the merlin: the courtship period. Raptor Research 19:60-67.

Fox, G. A. 1971. Recent changes in the reproductive success of the pigeon hawk. J. Wild. Manage. 35:122-128.

Hodson, K. A. 1976. The ecology of Richardson's Merlins on the Canadian prairies. M.S. Thesis, Univ. of Brit. Columbia, Vancouver, 83 pp.

Hodson, K. A. 1978. Prey utilized by merlins nesting in shortgrass prairies of southern Alberta. Can. Field-Nat. 92:76-77.

Johnsgard, P. A. 1990. Hawks, eagles and falcons of North America, biology and natural history. Smithsonian Institution Press, Washington, D. C., 403 pp.

Sieg, C. H. and D. M. Becker. 1990. Nest-site habitat selected by merlins in Southeastern Montana. The Condor 92:688-694.

Watson, J. 1979. Food of merlins nesting in young conifer forest. Bird Study 26:253-258.

American Kestrel

Balgooyen, T.G. 1976. Behavior and ecology of the American kestrel. Univ. Ca. Publ. Zool. 103:1-83.

Cade, T. J. 1982. The falcons of the world. Cornell Univ. Press. Ithaca, N.Y. 188 pp.

Heintzelmann, D.S., and A.C. Nagy. 1968. American kestrel reproduction in Pennsylvania. Wilson Bull. 80:306-311.

Millsap, B. A. 1981. Distributional status of falconiforms in west central Arizona: with notes on ecology, reproductive success and management. Tech. Note 355. U.S.D.I. Bur. Land Manage. Serv. Cent., Denver, Co., 102 pp.

Platt, S.W., and J.H. Enderson. 1989. Falcons. Pp. 111-117 *in* B.G. Pendleton, ed. Proc. of the Western Raptor Manage. Symp. and Workshop, Sci. and Tech. Series No. 12, Inst. for Wild. Re., Nat. Wild. Fed., Wash., D.C., 320 pp.

Sedgwick, J. A. and F. L. Knopf. 1990. Habitat relationships and nest site characteristics of cavity-nesting birds in cottonwood floodplains. J. Wild. Manage. 54:112-124.

Smith, D.G. and J.R. Murphy. 1973. Breeding ecology of raptors in Utah. Brigham Young Univ. Sci. Bull. Biol. Ser. 18:1-76.

Great Horned Owl

Austing, G. R. and J. B. Holt, Jr. 1966. The world of the great horned owl. Lippencott, Philadelphia.

Gilkey, A. K., W. D. Loomis, B. M. Breckenridge, and C. H. Richardson. 1943. The incubation period of the great horned owl. Auk 60:272-273.

Houston, C. S. 1971. Brood size of the great horned owl in Saskatchewan. Bird Banding 42:103-105.

Houston, C. S. 1975. Reproductive performance of great horned owls in Saskatchewan. Bird Banding 46:302-304.

Morrell, T.E., R.H.Yahner, and W.L. Harkness. 1991. Factors affecting detection of great horned owls by using broadcast vocalizations. Wildl. Soc. Bull. 19:481-488.

Petersen, L. 1979. Ecology of great horned owls and red-tailed hawks in southeastern Wisconsin. Wisc. Dept. Nat. Resour. Tech. Bull. No. 111:1-63.

Rohner, C. and F.I. Doyle. 1992. Methods of locating great horned owl nests in the boreal forest. J.Raptor Res. 26:33-35.

Long-eared Owl

Marks, J. S. 1986. Nest site characteristics and reproductive success of long-eared owls (*Asio otus*) in southwestern Idaho. Wilson Bull. 98:547-560.

Murray, G. A. 1976. Geographic variation in the clutch sizes of seven owl species. Auk 93:602-613.

Wijnandts, H. 1984. Ecological energetics of the long-eared owl (*Asio otus*). Ardea 72:1-92.

Short-eared Owl

Clark, R. J. 1975. A field study of the short-eared owl *Otus flammeus* (Pontoppidan) in North America. Wild. Monogr. 47:1-67.

Western Screech Owl

Hayward, G. D. 1983. Resource partitioning among six forest owls in the River of No Return Wilderness, Idaho. M. S. Thesis, Univ. Idaho, Moscow. 132 pp.

Johnson, R. R., L. T. Haight, and J. M. Simpson. 1979. Owl populations and species status in the southwestern United States. Pp 40-59 *in* P. Schaeffer and S. Ehlers, eds., Owls of the West: their ecology and conservation. Western Education Center, National Audubon Soc., Tiburon, CA.

Burrowing Owl

Grant, R. A. 1965. The burrowing owl in Minnesota. Loon 37:2-17.

Landry, R. E. 1979. Growth and development of the burrowing owl, Athene cunicularia, M.S. Thesis, California St. Univ., Long Beach.

Olenick, B. E. 1987. Reproductive success of burrowing owls using artificial nest burrows in southeasten Idaho. Eyas 10:38.

Olenick, B. E. 1989. Burrowing owl. Pp 79-81 *in* Clark, T. W., et al., eds. Rare, sensitive, and threatened species of the Greater Yellowstone Ecosystem. Northern Rockies Conservation Cooperative, Montana Natural Heritage Program, The Nature Conservancy, and Mountain West Environmental Services., Jackson, Wyo., 153 pp.

Stewart, R. E. 1975. Breeding birds of North Dakota. Tri-College Center for Environmental Studies, Fargo.

Wedgewood, J. A. 1976. Burrowing owls in south-central Saskatchewan. Blue Jay 34:26-44.

Great Gray Owl

Bull, E. L. and M. G. Henjum. 1990. Ecology of the Great Gray Owl. Gen. Tech. Rep. PNW-GTR-265, USDA For. Service, Pacific Northwest Research Station, Portland, Or, 39 pp.

Franklin, A. B. 1987. Breeding biology of the great gray owl in southeastern Idaho and northwestern Wyoming. M.S. thesis, Humboldt St. Univ., Arcata, California,

Franklin, A. B. 1988. Breeding biology of the great gray owl in southeastern Idaho and northwestern Wyoming. Condor 90: 689-696.

Nero, R. W. 1980. The great gray owl-phantom of the northern forest. Smithsonian Institution Press, Washington, D.C., 167 pp.

Barred Owl

Apfelbaum, S. I., and P. Seelbach. 1983. Nest tree, habitat selection and productivity of seven North American raptor species based on the Cornell Univ. nest record program. Raptor Research 17:97-113.

Bosakowski, T., R. Speiser, and J. Benzinger 1987. Distribution, density, and habitat relationships of the barred owl in northern New Jersey. Pp. 135-143 *in* Nero, R. W., R. J. Clark, R. J. Knapton, and R. H. Hamre eds., Biology and conservation of northern forest owls, Symposium Proceedings., U.S.D.A. Forest Service, Gen. Tech. Report RM-142.

Elody, B. I. and N. F. Sloan. 1985. Movements and habitat use of barred owls in the Huron Mountains of Marquette County, Michigan, as determined by radiotelemetry. Jack-Pine Warbler 63:3-8.

Hamer, T. and H. L. Allen. 1985. Continued range expansion of the barred owl (Strix varia) in western North America. Raptor Research Foundation, International Meeting, Sacramento, CA.

Murray, G. A. 1976. Geographic variation in the clutch sizes of seven owl species. Auk 93:602-613.

Nicholls, T. H. and D. W. Warner. 1972. Barred owl habitat use as determined by radiotelemetry. J. Wild. Manage. 36:213-224.

Nicholls, T. H. and M. R. Fuller. 1987. Territorial aspects of barred owl home range and behavior in Minnesota. Pp. 121-128 *in* Nero, R. W., R. J. Clark, R. J. Knapton, and R. H. Hamre eds., Biology and conservation of northern forest owls, Symposium Proceedings., U.S.D.A. Forest Service, Gen. Tech. Report RM-142.

Northern Pygmy Owl

Holt, D. W., and W.D. Norton. 1986. Observations of nesting northern pygmy-owls. J. Raptor Res. 20:39-41.

Reynolds, R.T., R.A. Ryder, and B.D. Linkhart. 1989. Small forest owls. Pp. 134-143 *in* Proc. western raptor management symposium and workshop. National Wildl. Fed. Washington D.C. 320pp.

Verner, J. and A. S. Boss. 1980. California wildlife and their habitats: Western Sierra Nevada. USDA, Forest Service, Gen. Tech. Report PWS-37.

Flammulated Owl

Bent, A. C. 1938. Flammulated screech owl. Pp. 291-295 *in* Life histories of North American birds of prey. Part 2. U. S. Natl. Mus. Spec. Bull. 170.

Bull, E.L., and R.G. Anderson. 1978. Notes on flammulated owls in northeastern Oregon. Murrelet 59:26-28.

Bull, E.L., A.L Wright, and M.G. Henjum. 1990. Nesting habitat of flammulated owls in Oregon. J.Raptor Res. 24: 52-55.

Cannings, R.J., and S.R. Cannings. 1982. A flammulated owl nests in a box. Murrelet 63:66-68.

Goggans, R. 1986. Habitat use by flammulated owls in northeastern Oregon. Thesis. Oregon State Unversity, Corvalis, Oregon, USA.

Hayward, G. D. 1989. Habitat use and population biology of boreal owls in the northern Rocky Mountains, U.S.A. Ph.D. Dissertation, Univ. Idaho, Moscow, 113 pp.

Howie, R.R., and R. Ritcey. 1987. Distribution, habitat selection, and densities of flammulated owls in British Columbia. Pp. 249-254 *in* Nero, R. W., R. J. Clark, R. J. Knapton, and R. H. Hamre eds., Biology and conservation of northern forest owls, Symposium Proceedings., USDA Forest Service, Gen. Tech. Report RM-142.

Linkhart. 1984. Range, activity, and habitat use by nesting flammulated owls in Colorado ponderosa pine forests. Thesis. Colorado State University, Fort Collins, Colorado, USA.

Marcot, B.G., and R. Kill. 1980. Flammulated owls in northwestern California. Western Birds 11:141-149.

McCallum, D.A. 1994. Review of technical knowledge: flammulated owl. Pp. 14-46 *in* Hayward, G.D., and J.Verner, tech. editors. Flammulated, boreal and great gray owls in the United States: A technical conservation assessment. Gen. Tech. Report RM-253. Fort Collins, CO: USDA, Forest Service 214 p.

Reynolds, R.T. and B. D. Linkhart. 1984. Methods and materials for capturing and monitoring flammulated owls. Great Basin Naturalist 44: 49-51.

Reynolds, R. T. and B. D. Linkart. 1987a. The nesting biology of flammulated owls in Colorado. Pp 239-248 *in* Nero, R. W., R. J. Clark, R. J. Knapton, and R. H. Hamre eds., Biology and conservation of northern forest owls, Symposium Proceedings., USDA Forest Service, Gen. Tech. Report RM-142.

Reynolds, R. T. and B. D. Linkart. 1987b. Fidelity to territory and mate in flammulated owls. Pp. 234-238 *in* Nero, R. W., R. J. Clark, R. J. Knapton, and R. H. Hamre eds., Biology and conservation of northern forest owls, Symposium Proceedings., USDA Forest Service, Gen. Tech. Report RM-142.

Reynolds, R.T., and B.D. Linkhart. 1992. Flammulated owls in ponderosa pine: evidence of preference for old growth. Pp. 166-169 *in* Old-growth forests in the southwest and Rocky Mountain regions: proceedings of a workshop. USDA, Forest Service, Gen. Tech. Report RM-213.

Winter, J. 1974. The distribution of the flammulated owl in California. Western Bords 5:25-44.

USDA, Forest Service. 1993. Region 4 sensitive species. Broadcast vocalization compact disc Payette National Forest: CD use information. Payette N.F. 11pp.

Northern Saw-Whet Owl

Cannings, R.J. 1987. The breeding biology of the northern saw-whet owls in southern British Columbia. Pp. 193-198 *in* Nero, R. W., R.J. Clark, R.J. Knapton, and R.H. Hamre. ed., Biology and conservation of northern forest owls, Symposium Proceedings, USDA Forest Service, Gen. Tech. Report RM-142.

Hayward, G. D. 1983. Resource partitioning among six forest owls in the River of No Return Wilderness, Idaho. M. S. Thesis, Univ. Idaho, Moscow. 132 pp.

Holt, D.W., E. Andrews, and N. Claflin. 1991. Non-breeding season diet of northern saw-whet owls, *Aegolius acadicus*, Nantucket Island, Massachusettes. Can. Field Naturalist 105(3): 382-385.

Marks, J.S. and J.H. Dormeus. 1988. Breeding-season diet of northern saw-whet owls in southwestern Idaho. Wilson Bull., 100(4): 690-694.

Marks, J. S., J.H. Dormeus, and R.J. Cannings. 1989. Polygyny in the northern saw-whet owl. Auk. Vol 106: 732-734.

Palmer, D. A. 1986. Habitat selection, movements, and activity of boreal and saw-whet owls. M. S. Thesis, Colorado State Univ., Fort Collins.

Palmer, D.A. 1987. Habitat selection, movements and activity of boreal and saw-whet owls. J. Raptor Res. 21(1): 45.

Palmer, D.A. 1987. Annual, seasonal, and nightly variation in calling activity of boreal and saw-whet owls. Pp. 162-168 *in* R.W. Nero, R.J. Clark, C.R. Knapton, and R.J. Hamre, ed., Biology and conservation of northern forest owls, Sypmosium Proceedings. USDA Forest Service, Gen. Tech. Report RM-142.

Boreal Owl

Bondrup-Nielsen, S. 1984. Vocalizations of the boreal owl (*Aegolius funereus richardsonii*) in North America. Canadian Field-Naturalist 98:191-197.

Eckert, K.R., and T.L. Savaloja. 1979. First documented nesting of the boreal owl south of Canada. American Birds 33:135-137.

Hayward, G.D., and E.O. Garton. 1983. First nesting record for boreal owl in Idaho. Wilson Bull. 94:690-692.

Hayward, G.D., P.H. Hayward, E.O. Garton, and R.Escano. 1987. Revised breeding distribution of the boreal owl in the northern Rocky Mountains. Condor 89:431- 432.

Hayward, G.D., and E.O. Garton. 1988. Resource partitioning among forest owls in the River of No Return Wilderness, Idaho. Oecologia 75:253-265.

Hayward, G. D. 1989. Habitat use and population biology of boreal owls in the northern Rocky Mountains, U.S.A. Ph.D. Dissertation, Univ. Idaho, Moscow, 113 pp.

Hayward, P. H. and G. D. Hayward. 1989. Boreal owl. Pp 84-86 *in* Clark, T. W., et al., eds. Rare, sensitive, and threatened species of the Greater Yellowstone Ecosystem. Northern Rockies Conservation Cooperative, Montana Natural Heritage Program, The Nature Conservancy, and Mountain West Environmental Services., Jackson, Wyo., 153 pp.

Hayward, G. D., R. K. Steinhorst, and P.H. Hayward. 1992. Monitoring boreal owl populations with nest boxes: sample size and cost. J.Wildl. Manage. 56: 777-785.

Hayward, G.D., P. H. Hayward, and E.O. Garton. 1993. Ecology of borel owls in the northern Rocky Mountains, USA. Wildlife Monographs 124:1-59.

Hayward, G.D. 1994. Review of technical knowledge: boreal owls. Pp. 92-127 *in* Hayward, G.D., and J.Verner, tech. editors. Flammulated, boreal and great gray owls in the United States: A technical conservation assessment. Gen. Tech. Report RM-253. Fort Collins, CO: USDA, Forest Service 214 p.

Johnsgard, P.A. 1988. North American owls. Smithsonian Institution Press, Washington DC, USA.

Palmer, D.A. and R.A. Ryder. 1984. The first documented breeding of boreal owl in Colorado. Condor 86:215-217.

Palmer, D.A. 1986. Habitat selection, movements and activity of boreal and saw-whet owls. Thesis. Colorado State Univ., Fort Collins, Colorado, USA.

Palmer, D.A. 1987. Annual, seasonal, and nightly variation in calling activity of boral and northern saw-whet owls. Pp. 162-168 *in* Nero, R.W., R.J. Clark, R.J. Knapton, and R.H. Hamre. Biology and conservation of northern forest owls, Symposium Proceedings. USDA Foret Service Gen. Tech. Report RM-142.

Stahlecker, D.W., and J.W. Rawinski. 1990. First records for the boreal owl in New Mexico. Condor 92:517-519.

Whelton, B.D. 1989. Distribution of the boreal owl in eastern Washington and Oregon. Condor 91:712-716.

Habitat Management and Alteration

Kochert, M. N. 1987. Responses of raptors to livestock grazing in the western United States. Pp. 194-203 *in* B. G. Pendleton, ed., Proc. Western Raptor Manage. Symp. and Workshop, Nat. Wild. Fed. Sci. and Tech. Ser. No. 12, Boise, Id, 317 pp.

Lee, L. C., T. A. Muir, and R. R. Johnson. 1987. Riparian ecosystems as essential habitat for raptors in the American west. Pp. 15-26 *in* B. G. Pendleton, ed., Proc. Western Raptor Manage. Symp. and Workshop, Nat. Wild. Fed. Sci. and Tech. Ser. No. 12, Boise, Id, 317 pp.

Reynolds, R.T. 1983. Management of western coniferous forest habitat for nesting accipiter hawks. For. Ser. Gen. Tech. Rep. RM-102.

Risebrough, R. W. and J. G. Monk. 1987. Toxic chemicals and birds of prey: a perspective in 1987. Pp. 245-255 *in* B. G. Pendleton, ed., Proc. Western Raptor Manage. Symp. and Workshop, Nat. Wild. Fed. Sci. and Tech. Ser. No. 12, Boise, Id, 317 pp.

Wilcox, B. A. 1987. The long-term consequences of environmental perturbations on raptor populations. Pp. 263-270 *in* B. G. Pendleton, ed., Proc. Western Raptor Manage. Symp. and Workshop, Nat. Wild. Fed. Sci. and Tech. Ser. No. 12, Boise, Id, 317 pp.

Young J. A. and B. A. Sparks. 1985. Cattle in the cold desert. Utah St. Univ. Press, Logan, 320 pp.

Young, L. S. 1987. Effects of agriculture on raptors in the western United States: an overview. Pp. 209-218 *in* B. G. Pendleton, ed., Proc. Western Raptor Manage. Symp. and Workshop, Nat. Wild. Fed. Sci. and Tech. Ser. No. 12, Boise, Id, 317 pp.

Appendix Table 1. A bald eagle monitoring plan for GYE/Idaho with area specific suggestions for monitoring methods and dates and estimates of time needed, December, 1994.

Palisades Reservoir area — Activity 3 days; Productivity 4 days

5 territories, all on Forest Service: Hoffman, King Creek, Williams Creek, Edwards Creek, Van Point. Incubation in this area usually begins approximately one month after South Fork sites, about April 1, with the exception of Hoffman and King Creek, which begin earlier. It is efficient to monitor these sites from identified ground points.

Upper South Fork — Activity 6 days; Productivity 7 days

9 territories, BLM, Forest Service, and private. Palisades Creek, Swan Valley, Conant Valley, Pine Creek, Dry Canyon, Gormer Canyon, Wolverine, Antelope Creek, Cress Creek. All of these sites are highly visible from ground locations and are accessible by ground or boat survey. Incubation begins in late February to mid-March, with Gormer Canyon typically the latest site to initiate.

Lower South Fork, Main Snake, Lower Henry's — Activity 3 days; Productivity 4 days

4 territories, BLM, F&G, and private: Confluence, Cartier Slough, Menan Buttes, Market Lake. Incubation begins about March 1. Surveys by air or boat needed for some sites.

Middle Henry's Fork — Activity 3 days; Productivity 4 days

6 territories, BLM and private: St. Anthony, Singleton Pond, Teton River, Kerr Canyon, Hale Canyon, Lower Fall River. Incubation begins about March 1. Surveys by air needed for some sites, others by ground survey.

Upper Henry's Fork — Activity 5 days; Productivity 8 days

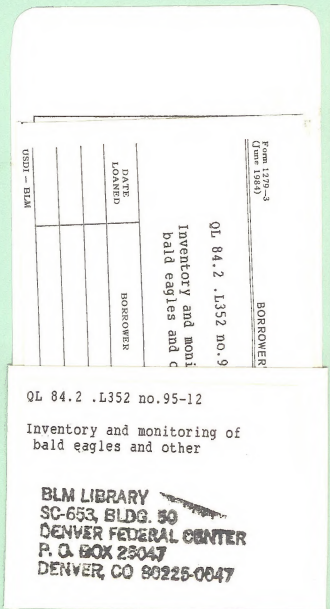
5 territories, Forest Service: Riverside, Snake River Butte, Pine Haven, Moonshine, Last Chance. Incubation begins mid-March. Ground surveys most effective. Aerial survey can be helpful in location of new alternate nest sites.

Island Park Reservoir and vicinity — Activity 8 days; Productivity 12 days

5 territories, Forest Service, BLM, private or state: Box Canyon, Coffee Pot, IP Bills, Buffalo River, Bishop Lake, Sheridan. Incubation begins in mid- to late-March. Mostly ground surveys, although aerial survey can be helpful in location of new nest sites.

Henry's Lake and vicinity — Activity 3 days; Productivity 5 days

4 territories, all Forest Service: Lucky Dog, Flat Rock, Henry's Lake, Staley Springs-Targhee Creek. Incubation begins in mid-March. Mostly ground surveys, although aerial survey can be helpful in location of new nest sites.



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